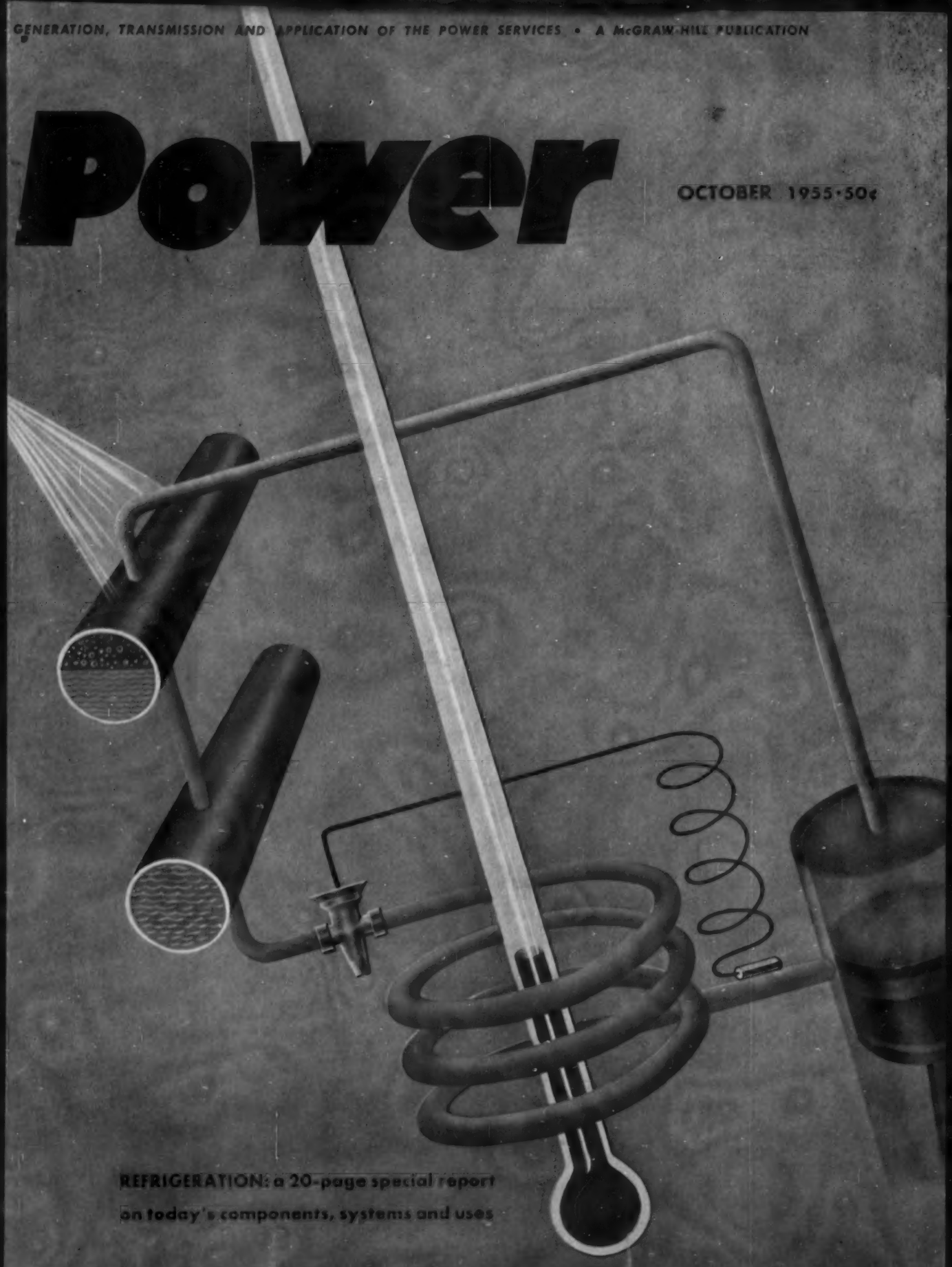
GENERATION, TRANSMISSION AND APPLICATION OF THE POWER SERVICES • A McGRAW-HILL PUBLICATION

Power

OCTOBER 1955·50¢



REFRIGERATION: a 20-page special report on today's components, systems and uses

The A-S-H Hydro-Ejector for conveying solids...

Cut-away view illustrates operation and typical arrangement of Hydro-Ejector application.

Where jet apparatus is indicated, we suggest our improved A-S-H Hydro-Ejector—most efficient of all jet pumps.

Simplicity of Design. Dependable operation is insured by the simple and compact design of the unit. The Hydro-Ejector corresponds closely in size and shape to the transporting pipeline. There is a minimum of joints or other restrictions to flow. All joints are machined and gasketed. The jet nozzle tip is located out of the path of the materials being handled and thus doesn't interfere with the free flow of solids.

Trouble-free Operation. High pressure water admitted through the jet nozzle transports solid materials at high velocity through a diverging throat into the transport piping. Iron pyrites can be transported in the same system with bottom ash or furnace slag. This combined operation saves time and water, and uses the greater specific gravity of a water-and-ash mixture to convey the heavy pyrites more efficiently. The Hydro-Ejector cannot become air-bound. All units are shop tested under service conditions before shipment.

Low Maintenance. Long service life is assured by (a) use of wear resistant materials (b) use of few connecting joints within the unit and (c) locating the jet nozzle tip out of the path of material in transport. Special gaskets are available to withstand effects of acids, alkalis and high temperatures.

Simplicity of Installation. Installing the Hydro-Ejector as a unit is a simple operation. It is factory assembled and has only three points of attachment. Maintenance problems are minimized since the unit is easily assembled and disassembled.

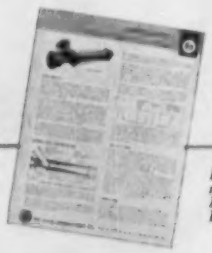
The **Allen-Sherman-Hoff** Company

259 E. Lancaster Ave., Wynnewood, Pa.

Offices and Representatives in Principal Cities

MATERIALS HANDLING SYSTEMS

hydrojet *hydraulic* / **hydrovac** *pneumatic*



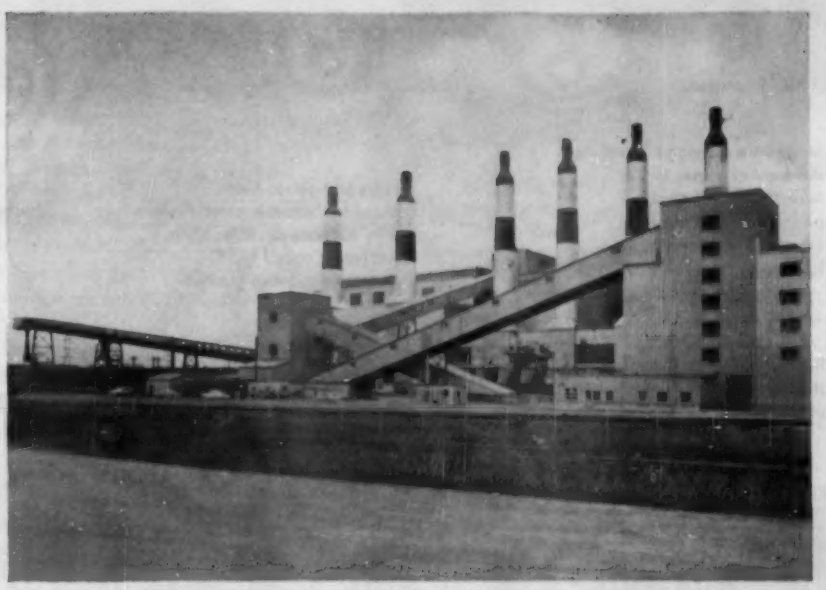
For complete information on Hydro-Ejectors send for Data Sheet Ea.

Coordinates coal handling for
3 stockpiles at Ridgeland Station

LINK-BELT builds and installs system for 1.3 million tons

RIDGELAND Station is an outstanding example of coal handling flexibility. By arrangement of parallel conveyors with chutes and motor-operated gates, the system can handle up to 1,600 tons of coal per hr. And should a fuel emergency arise, coal can be reloaded from storage to barges and transferred to other stations in the Commonwealth Edison system.

Whether your plant is large or small . . . your problems simple or complex—it's Link-Belt for top coal handling efficiency. Our engineers will gladly work with your own engineers and consultants to provide the lowest cost per ton handled.



Ridgeland Station of the Commonwealth Edison Company has one of the largest single station coal storage capacities in the Midwest. Handling provisions include receiving by barge or rail, conveying to and from storage, breaking and crushing for cyclone firing, and delivery to bunkers. Sargent & Lundy were consulting engineers.

LINK-BELT

COAL HANDLING EQUIPMENT

3. Coal loaded onto dock belts by crane or tower moves to junction house, then to station or on this inclined conveyor to 800,000-ton storage area.

1. Traveling bridge crane unloads coal from barges to 350,000-ton reserve or to belt conveyor leading to station.

2. Stationary tower also unloads barges, empties to 170,000-ton storage area or hopper feeding 42-in. belt conveyor.

4. Parallel belt conveyors and flexible chute arrangements like this over bunkers assure steady feed of coal.

5. Discharging coal through dust seals, trippers are propelled along distributing conveyor by Link-Belt drive.

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.
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DE LAVAL
OPPELLER PUMPS

last longer... cut maintenance costs

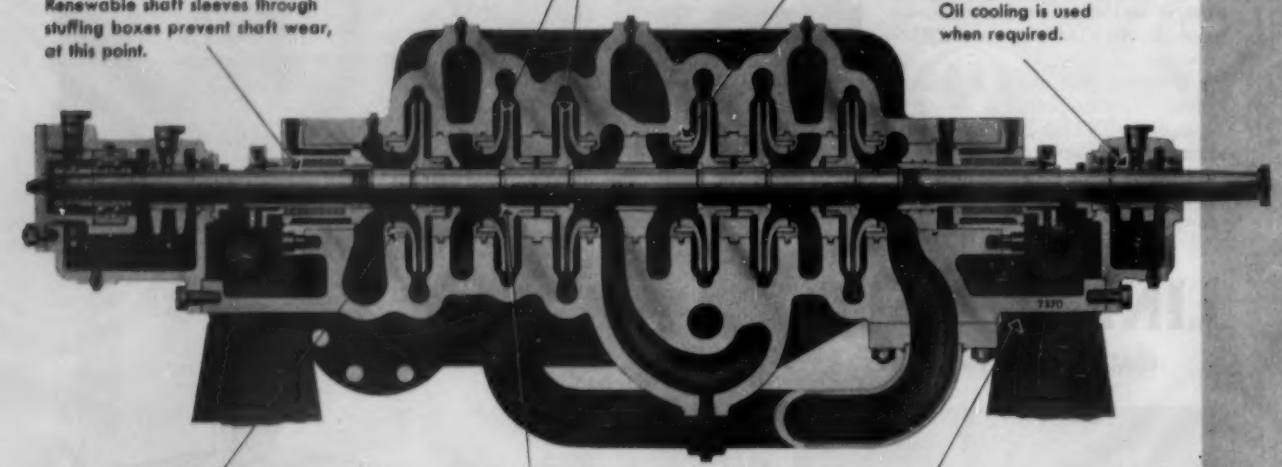
Stages are arranged to reduce differential pressures between stages. This insures permanent sealing at the casing-joint and at interstage diaphragms.

Pairs of back-to-back impellers balance axial thrust. One-purpose thrust bearing carries no radial load, maintains axial alignment.

Labyrinth wearing rings permit safe clearances and reduce wear.

All bearings are ring-oiled, sealed against contamination by water or dust. Oil cooling is used when required.

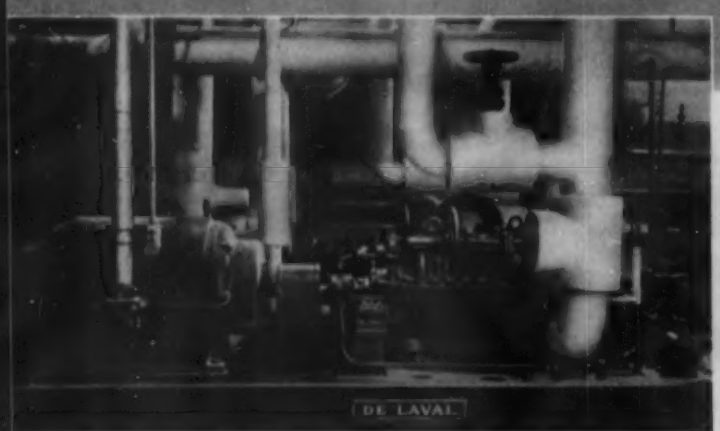
Renewable shaft sleeves through stuffing boxes prevent shaft wear, at this point.



Threaded impeller wearing rings make replacement easy without heating or damage to impellers.

Individual impeller mountings, with split locating rings, make interstage shaft sleeves unnecessary. Impellers can't shift with shaft expansion and contraction.

Casing support insures coupling alignment at any operating temperature.



Here are two De Laval 6-stage Oppeller Pumps used for boiler feed service in an industrial installation.

The design features above show clearly why De Laval Oppeller Pumps stay on the line longer and cost less to maintain. These pumps are used for boiler feed, hydraulic systems, descaling spray, mine dewatering, refinery oil pumping and similar services.

De Laval Oppeller Pumps are available in sizes from 2 to 4 inches and 2 to 8 stages; capacities to 1000 gpm, pressures to 1200 psig and temperatures to 350°F. *For complete data, write for De Laval Catalog 1502.*

DE LAVAL *Oppeller Pumps*

DE LAVAL STEAM TURBINE COMPANY

815 Nottingham Way, Trenton 2, New Jersey

Power

OCTOBER 1955 • VOLUME 99 NUMBER 10

ENGINEERING AND MANAGEMENT

REFRIGERATION: a 20-page report of timely importance 75
How refrigerating machines make cold 76
Refrigeration compressors and components 78
System components—piping, valves, controls 82
Applications of refrigeration equipment 86
Equipment selection and use on the job 92
Nuclear notes: News of latest developments 95
Effect of sudden load drop on pumps in open feed cycles 96
How to select today's high-voltage ac-motor controllers 98
Con Edison completes F-R turbine lube test 101
Nuclear-research laboratory battling for economical atomic power 102
Best operation of burners, stokers and combustion air 106
Novel equipment for coolant systems: Nuclear study course No. 14 108
Data sheet: Angles for fabricated-pipe bends 111

PLANT OPERATION AND MAINTENANCE

What it's like to run a reactor 115
Here's your air-operated diaphragm-controlled valve 118
Are actual steam-trap capacities less than guaranteed? 120
Your diesel turbocharger needs this care 122
Seven steps in choosing pumps for thick liquids, paper stock 124
A practical approach to compressed-air maintenance 128
When you know how fires start you can cut down plant-fire loss 130
Will today's vacuum switch become tomorrow's breaker? 132
Electrical heat cuts cost in growing number of process loads 134
Practical ideas 136
Plant problems 142
Arguments 148
How-to 150
Fluid facts: No. 2 in a series 152
Marmaduke Surfaceblow 154

READER SERVICE SECTION

This month's service features 158
Reports from the field 160
Technical briefs 162
Plant equipment news 166
New free bulletins 175
George Edwards 178

Print order this issue: 47,311

OCTOBER 1955 POWER Vol. 99—No. 10

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POWER articles are indexed in both the *Industrial Arts Index* and the *Engineering Index*. POWER publishes its own annual index.

REFRIGERATION THEME of this month's cover, was developed during a 10-minute "brainstorming" session by POWER staffers Ty Hicks, Charlie Marschalek and Jim O'Connor. Once the simple sketch was agreed on, Art Editor Charlie Marschalek worked up a layout in color to guide the artist. At this point McGraw-Hill illustration department took over, did a nice job.

Report itself, p 75, packs into 20 pages all the latest pertinent data on refrigeration systems, components, applications. It's another job Associate Editor Ty Hicks can be mighty proud of along with the string of successes he's chalked up in the form of past special reports.

Next month . . .

Modernization Award recipient, the John Strange Paper Co in Menasha, Wis., kicks off a series of articles on plants receiving POWER's '55 awards. Revamping the key power services here means steam and electrical power costs per ton of paper will be trimmed 29%, placing the plant among the country's best in terms of Btu's used per ton.

Control-valve selection is based on a few well-proven points. Hal Kinney of Fisher Governor Co outlines them in an upcoming article, cites factors to consider in matching valve to job.

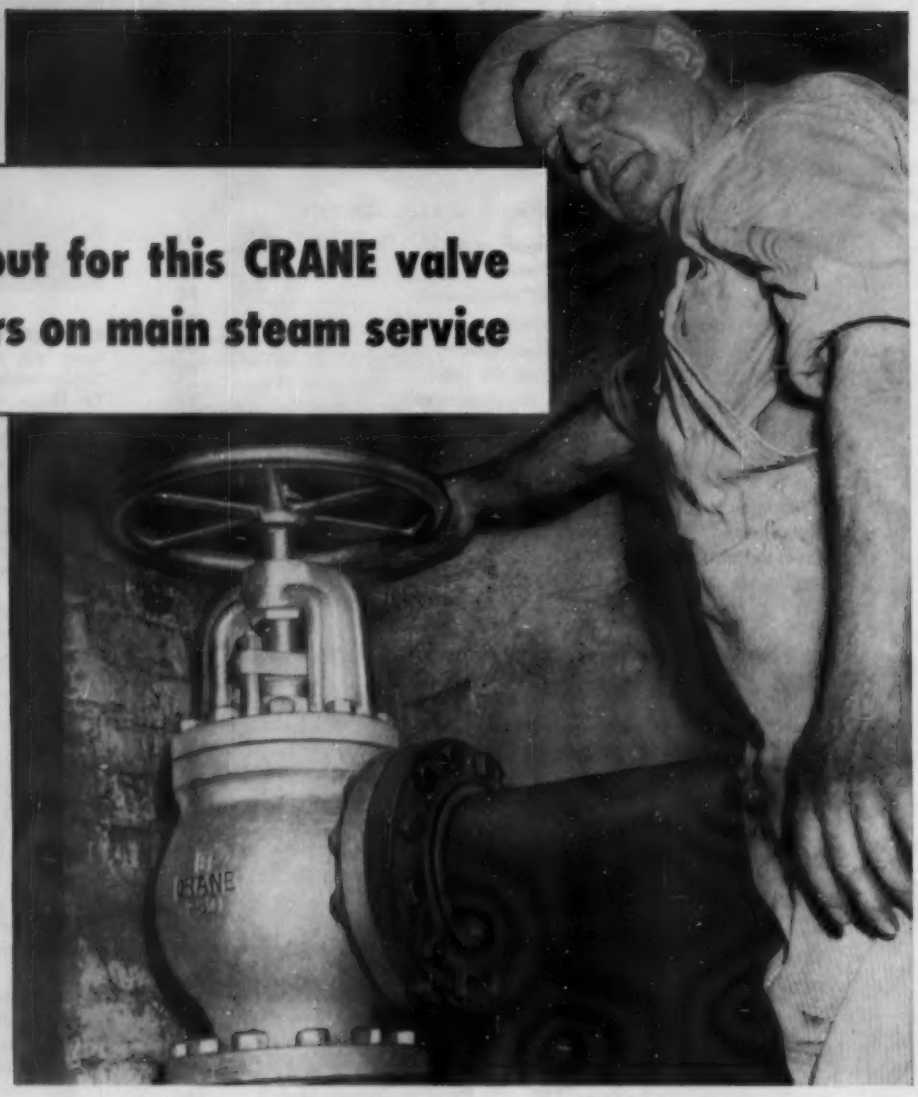
Compressed air a problem? Whether you're toying with plans to revamp your air system or build a new one, you'll want to review all the angles involved in planning a system. They're covered in this November article.

Ion exchange is a unit operation for trading unwanted ions in solution for those desired. But keeping operating bugs out of a system requires much more than the simple definition. Next month read how maintenance and trouble-shooting schemes can be streamlined, reducing your headaches.

. . . and future months

Atomic Energy Today, a 24-page round-up with facts and figures on what's happening in the nuclear field, will appear in December. Don't miss it.

No time out for this CRANE valve in 40 years on main steam service



THE CASE HISTORY—Two Crane 250-pound iron body angle valves—6-inch (shown) and 5-inch size—scored this exceptional service record.

They were installed in 1915 on the main steam leads from boilers in the plant at Delavan, Wis., now occupied by The George W. Borg Corporation. In 40 years' uninterrupted service these Crane valves never failed to operate properly nor caused a shutdown. With but routine maintenance, they opened fully and were seated tight with ease under infrequent operation. Working pressure of boilers was originally 150 psi.—later reduced to 75 psi. This year, both valves were retired. The new replacements are Crane quality valves, of course.

Crane iron valves in particular need no introduction to thrifty buyers. In all grades, Crane iron castings generously exceed the requirements of equivalent A.S.T.M. specifications. Crane Ferrosteel, for instance, used in 250-pound valves is 35% stronger than ordinary cast iron.

In any pressure class, you'll find Crane quality outstanding. Choose from complete lines of gates, globes, angles and checks. Your Crane Representative can give valuable help in specifying and ordering.

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CRANE'S FIRST CENTURY...1855-1955

speaking of Power

Fred Annett: A study on how to retire, and like it

Annett at 76, four years retired

Many engineers reach for retirement with mixed emotions: happy at the thought of slipping out from under daily pressures, yet wondering if the big void can really be filled by loafing in an armchair or fiddling in the garden. Fred Annett faced that milestone, August 1951, when he stepped down as senior Associate Editor of POWER after 35 highly successful years that built him an enviable reputation.

With characteristic Annett planning, Fred was determined to keep right on being young and useful after retirement. So on assuming the position of Contributing Editor, he simply sidestepped the tyranny of deadlines for a well-planned life of work and play.

Four years later, Fred has proven his point: You can retire and really enjoy every minute if you blend the right amount of work into your play. Since retirement, Fred has seldom missed a week without spending a day or two at his old desk answering mail, planning and writing. Each year Fred Annett compiles the hydroelectric plant tables for POWER's Modern Plant Survey, published in mid-September. He continues to know all the significant facts about all the important hydroelectric plants in the United States and Canada.

Revising his books, which have sold well over 200,000 copies to date, has taken a sizable chunk of Fred's time. Second edition of *Pumps* appeared in 1953; this year the third edition of *Connecting and Testing Direct-Current Machines* left the press. Right now he is deep in the second revision of *Electric Elevators*.

Lighter side of Fred's retirement assumes many forms. A clear day may see him and Mrs Annett starting out on a long, pleasant drive on Long Island, with plans for a leisurely stop at one of the better eating spots. At home, Fred still feeds bushels of grain to several hundred birds each winter. And in summer, when not tending his flowers, he sits on the veranda, reading, studying, and watching current events with a keen and mistrustful eye.

But this summer was different. We were deep in several editorial projects and found ourselves temporarily short-handed—a general industrial summer complaint. It was mentioned to Fred in passing. Without batting the proverbial eyelash, he stepped in, filling the breach.

Back in harness, at least for a month or so, Fred once again displayed his bent toward filling needs. With the thermometer hovering over 90, he assumed, temporarily, a full editorial mantle.

Coming into the office on his 76th birthday, Fred found the POWER editorial staff gathered about his desk, complete with birthday cake. Fred chuckled, shook hands, spent little time reminiscing. He had to check press proofs of his hydro tables for the mid-September issue . . . put a final polish on his articles for October (see p 98) . . . discuss progress on a book revision with our Book Company people . . . and meet Mrs Annett to take in the new show at Radio City Music Hall. We couldn't help but feel, as Fred went about his tasks with characteristic vigor, that he had found his solution to a problem stumping many people: How to retire and like it.

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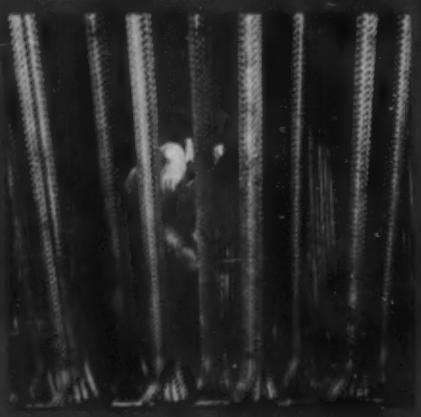
The pictures below show significant steps in the shop fabrication and assembly of B&W's Universal Pressure Steam Generator for Philo Plant.

B&W Universal

Assembly, complete and ready for shipment, of the second pass side wall is about 55 feet long, 5 feet, 6 inches wide. Alloy tubes are strength welded into the headers.

Floor tubes for secondary front wall assembly are carefully inspected for correct alignment.



An intricate job of bending, studding, and nesting characterizes the screen and floor for the secondary front wall.

Support castings being welded on flexible, small diameter tubes for roof assembly. Note that each tube end has a steel plug in it for cleanliness and future hydrostatic tests.

Shop assembly of secondary front wall. Note assembly frame which was made of plates and pipes welded together, but was not attached physically to the tube assembly at any point.

Secondary front wall section of alloy tubes and headers on its way to be completely stress relieved after assembly.

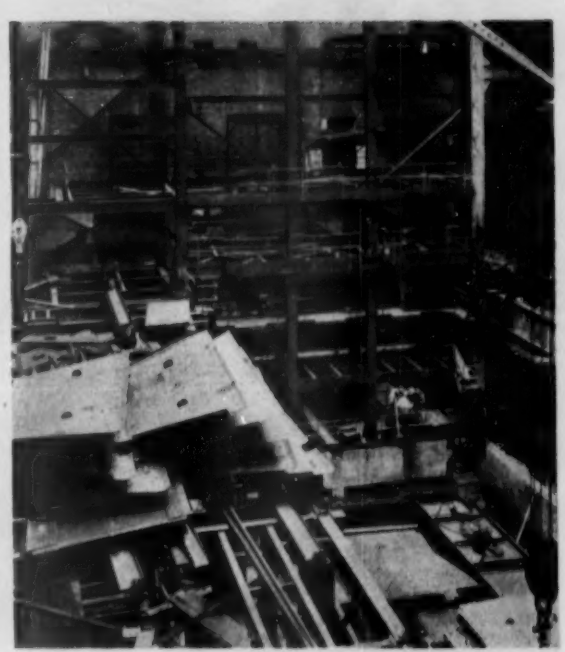
Pressure Steam Generator erection begins at Philo Plant

Final field erection has started on the world's first commercial supercritical pressure steam generator. At the Philo Plant of the Ohio Power Company, on the American Gas and Electric System, shop-assembled components of B&W's Universal Pressure Steam Generator are now being erected. It will supply steam at 4500 psi, 1150 F to a 125,000-kw turbine, and there will be two stages of reheat. Expected net heat rate is 8500 Btu per kilowatt hour.

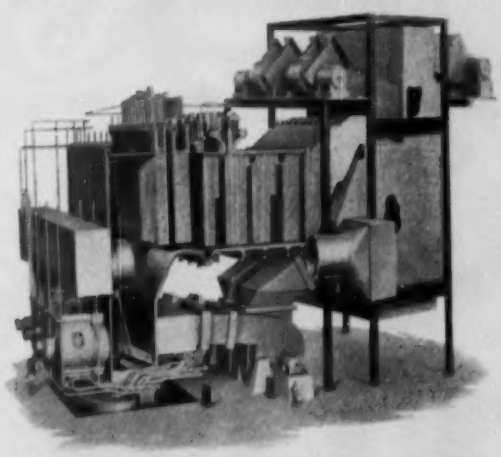
The complete installation at Philo Plant represents a new break-through in steam electric generating efficiency. In the words of Phillip Sporn, President of American Gas and Electric Service Corp.:

"The Philo project reflects the outstandingly dynamic character of the electric power industry. Here, in the very important field of energy generation, new frontiers are being pushed forward. Here, new avenues of approach to improvement in capital costs, in efficiency and in operating costs, are being opened. And, in keeping with the tradition that has characterized the growth and development of the industry, the results of this pioneering achievement will be made available to the rest of the industry.

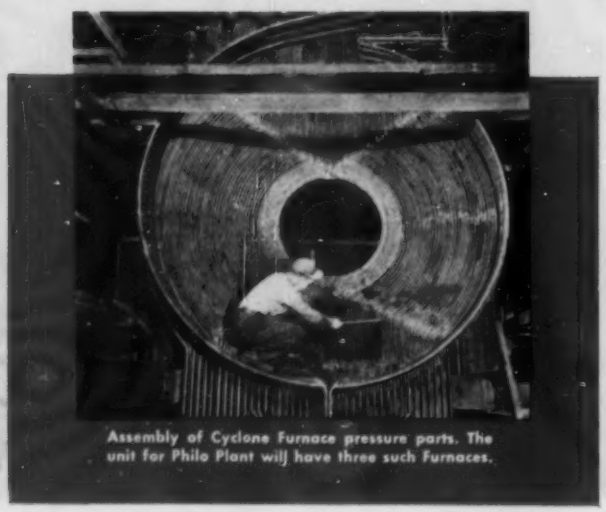
"The electric power industry, far from challenging any particular method of generating energy, demonstrates by this Philo project its readiness to adopt and bring forward every new development that can advance its technical and economic well being."



Start of boiler erection at Ohio Power Company's Philo Plant.



Sectional View of B&W Universal Pressure Steam Generator.



Assembly of Cyclone Furnace pressure parts. The unit for Philo Plant will have three such Furnaces.

G-730

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BOILER DIVISION

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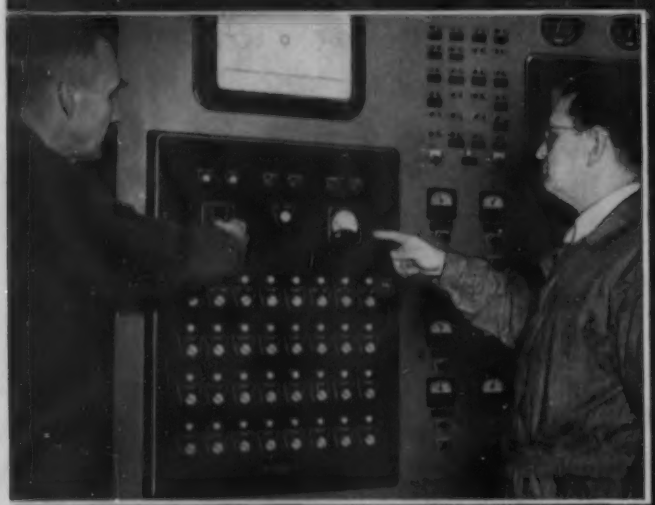

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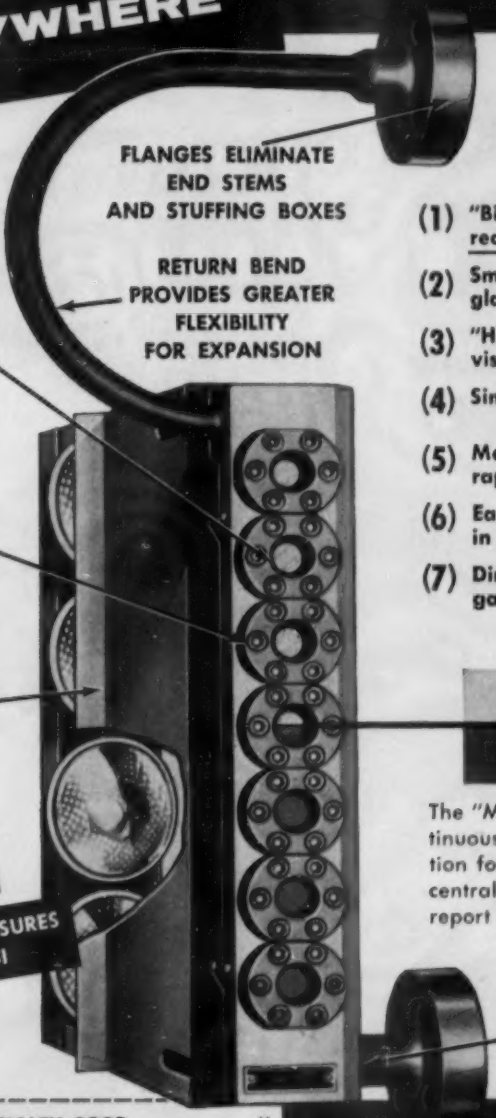
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(5) Maximum thermal stability for rapid starting

(6) Easy, inexpensive maintenance . . . in place

(7) Direct reading . . . basic reference gauge

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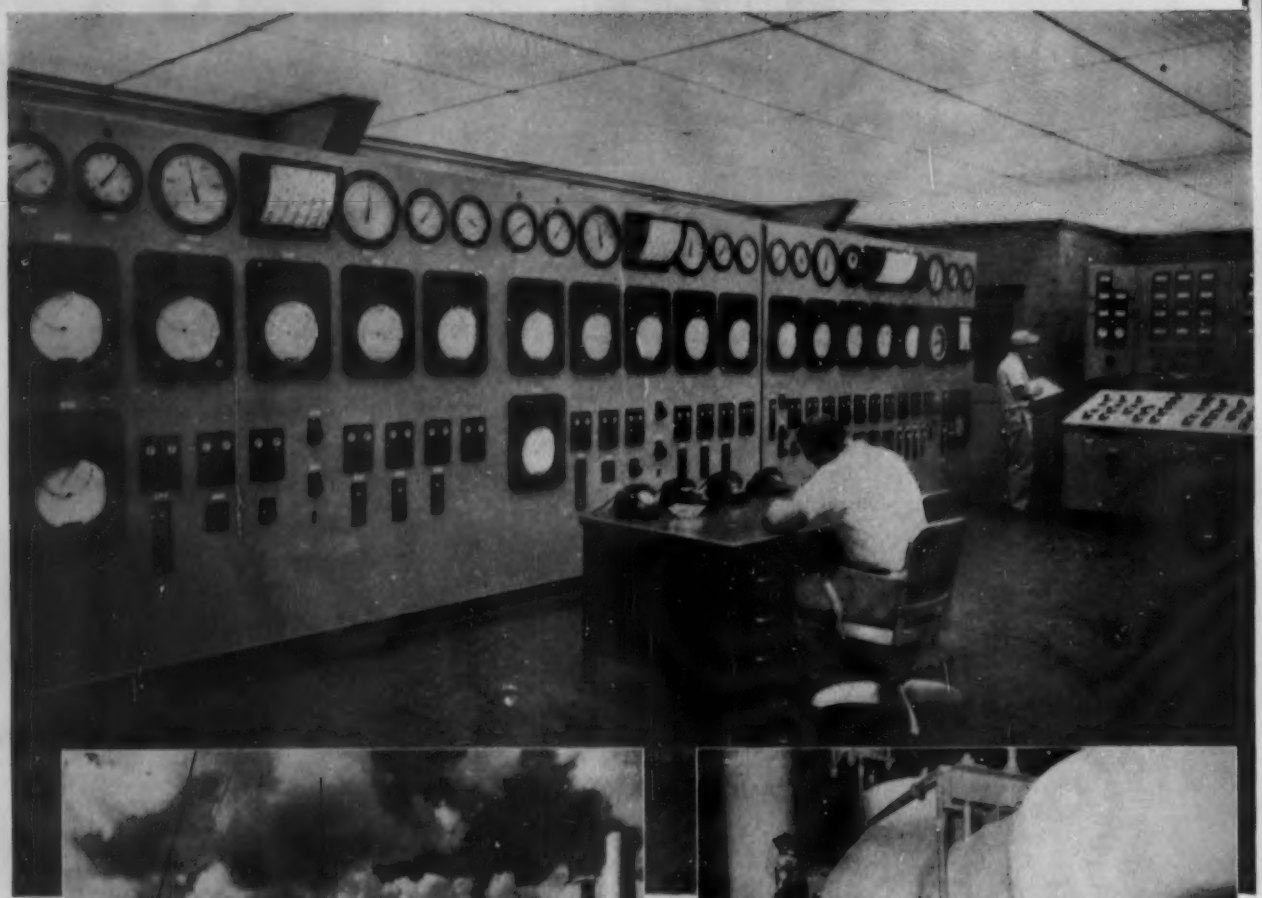

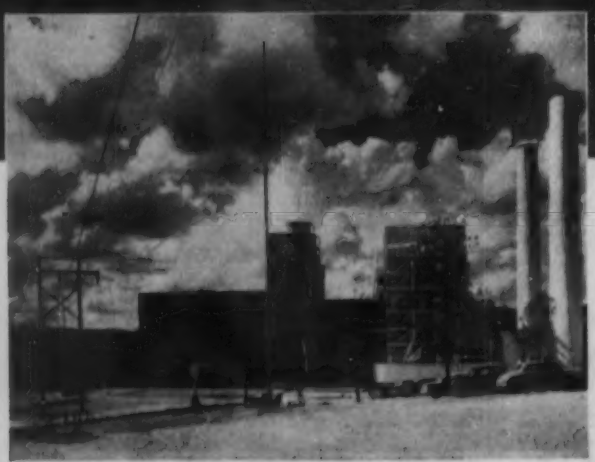

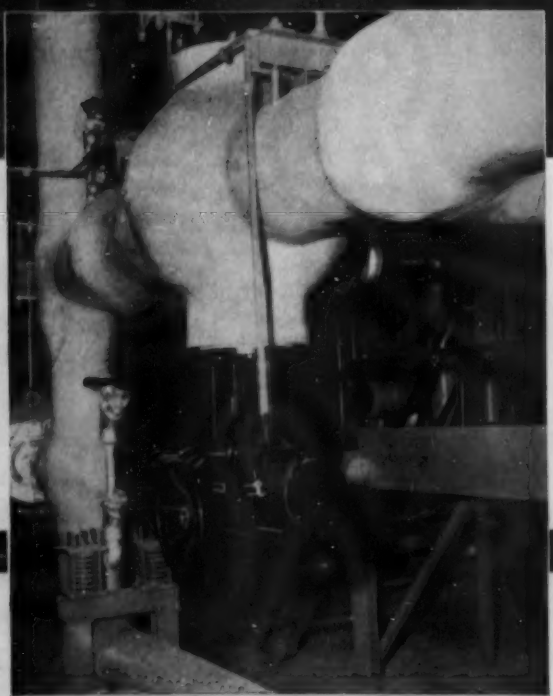

**At Lake Catherine Station,
Arkansas Power and Light Company**

Above—Centralized control room for Bailey Controls of Feed Water, Combustion and Steam Temperature.

Right—Bailey Three-element Feed Water Control Valve.

Installation of . . .

Bailey Three-element Feed Water Control

★ This installation of three-element feed water control at the Lake Catherine Station of Arkansas Power and Light Company is not the latest, the largest, or the most unusual; but it is important to you as a user of power generating equipment.

Here's why: It is a part of the widespread and well founded acceptance of Bailey Three-element Feed Water Control Systems. No other manufacturer can offer you an equal background of experience in this advanced method of feed water control.

Contributing to this overwhelming endorsement are several factors: Not only has the basic principle been proved and re-proved in use, but the design of the equipment has been similarly stabilized and improved. As a result, Bailey has established a reputation for successful operation in difficult installations where other systems have failed. And a twenty-five year backlog of experience has contributed unusual records for accuracy and dependability in operation.

Even more important, the Bailey field engineering service, established in important industrial centers, insures prompt and efficient service and installation supervision regardless of your location. Your local Bailey office will be glad to arrange an inspection trip to a near-by installation of Bailey Three-element Feed Water Control. Give them a call today. And for catalog literature, including a partial list of installations, write for Bulletin No. 105-C.

A-122-2

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PRESSURE
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FEED PUMPS

Elliott – playing a vital part in today's power

New Martins Creek Station features outdoor construction, low capacity factor and quick start-up

This new Pennsylvania Power and Light Company Station in eastern Pennsylvania is a model for modern power generation. Its economical outdoor design requires only the principal operating areas to be enclosed. Moderate steam pressures and temperatures, small size condenser and the absence of reheat all are the result of the expected low capacity factor operation. In addition, the initial 132,500-kw unit is designed and instrumented so that it may be shut down at night or over weekends, yet started up again quickly.

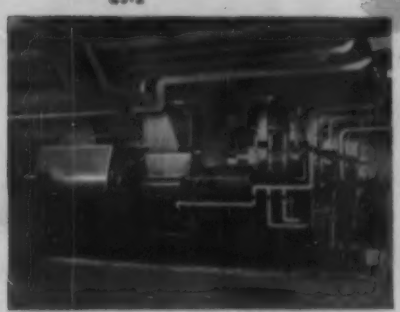
Elliott equipment including large deaerating feedwater heaters, evaporator preheaters, strainers, and the electric motors, 1½ to 2500 hp, which drive important station auxiliaries, plays a vital part in the efficient operation of the station.

For descriptive literature on up-to-date, cost-saving steam and electric equipment, write Elliott Company, Jeannette, Pa.

ELLIOTT Co[illegible]

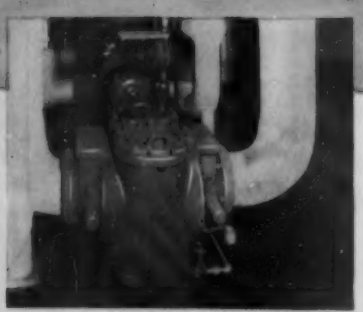
STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • [illegible] • [illegible] • CENTRIFUGAL COMPRESSORS

G5-2



Three Elliott 2500-hp, 3600-rpm induction motors driving boiler-feed pumps.

Chlorine booster pump, driven by Elliott motor and protected by Elliott Twin strainer.

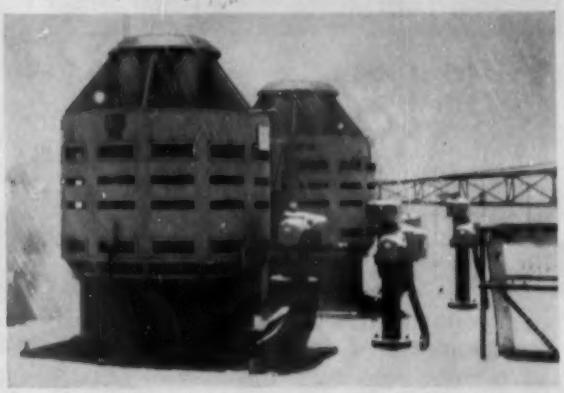


Elliott raw water strainer and two Elliott C-W motors driving pumps.

expansion . . .

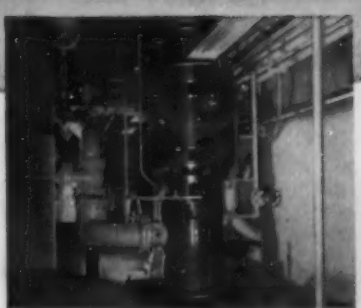
A close-up of the Elliott 1,400,000-lb-per-hr deaerating feedwater heater, serving the first unit.

Unit No. 1 of the new Martins Creek Steam Electric Station is operating, with duplicate unit under construction.

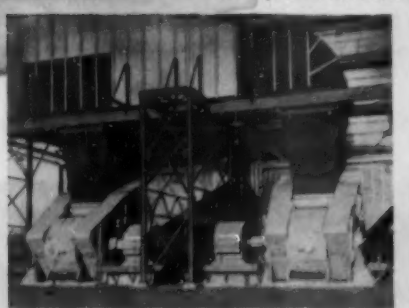


Two Elliott 500-hp, 440-rpm vertical weather-protected motors driving circulating water pumps during snowstorms.

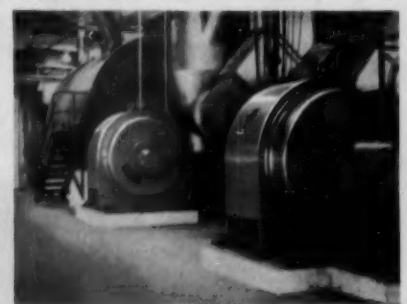
The snow doesn't bother this Elliott 700-hp, 1200-rpm, weather-protected motor driving forced-draft fan.



Elliott 350-hp, 1200-rpm vertical motors drive condenser hotwell pumps.



Two Elliott 1250-hp, 900-rpm, weather-protected motors driving induced-draft fans.



Two of the four Elliott 600-hp, 360-rpm motors which drive pulverizer mills.

VULCAN *because of...*

Long

DUAL MOTOR DRIVE

Vulcan uses two motors. One extends and retracts the lance. The other rotates it. Motors may be air or electric. Speeds are independently adjustable.

JET AND LANCE DESIGN

Vulcan offers jets tailored to the job—straight bore or venturi; and angled to reach specific surfaces. Jets normally rotate while traversing, but may traverse only or oscillate through any angle. Lances from opposite sides of the furnace may fail to "meet" by as much as 12 feet, yet clean thoroughly.

CHOICE OF BLOWING MEDIUM

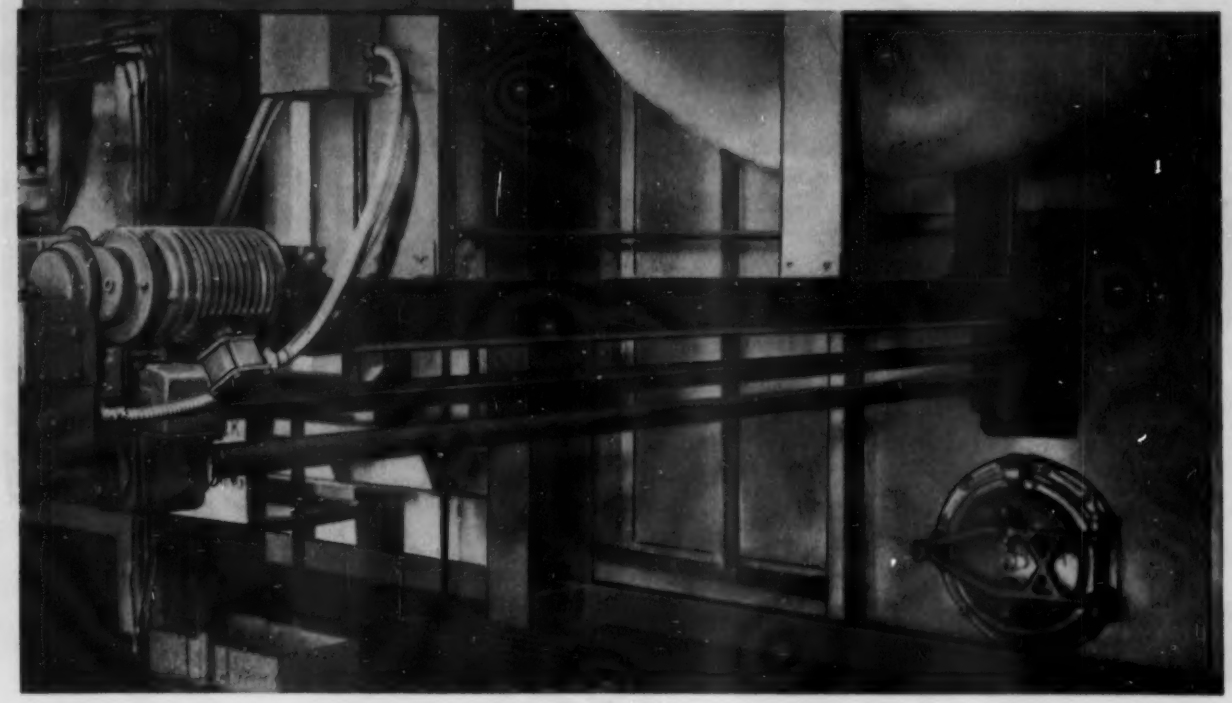
You can blow with any medium—air, steam or water, or any combination of them—*without change of equipment.*

CHANGE OF PACE

Two motors allow stop-and-go indexing with uniform rotation—or fast-and-slow change of pace. On "stop and go," the lance is stopped and rotated to clean the tubes—then sped across the open areas to the next row of tubes. On "fast and slow," the lance is slowed to clean the tubes, and sped while passing open areas. In each case, the result is a saving of blowing medium.

VULCAN *Automatic*

Retracts clean better



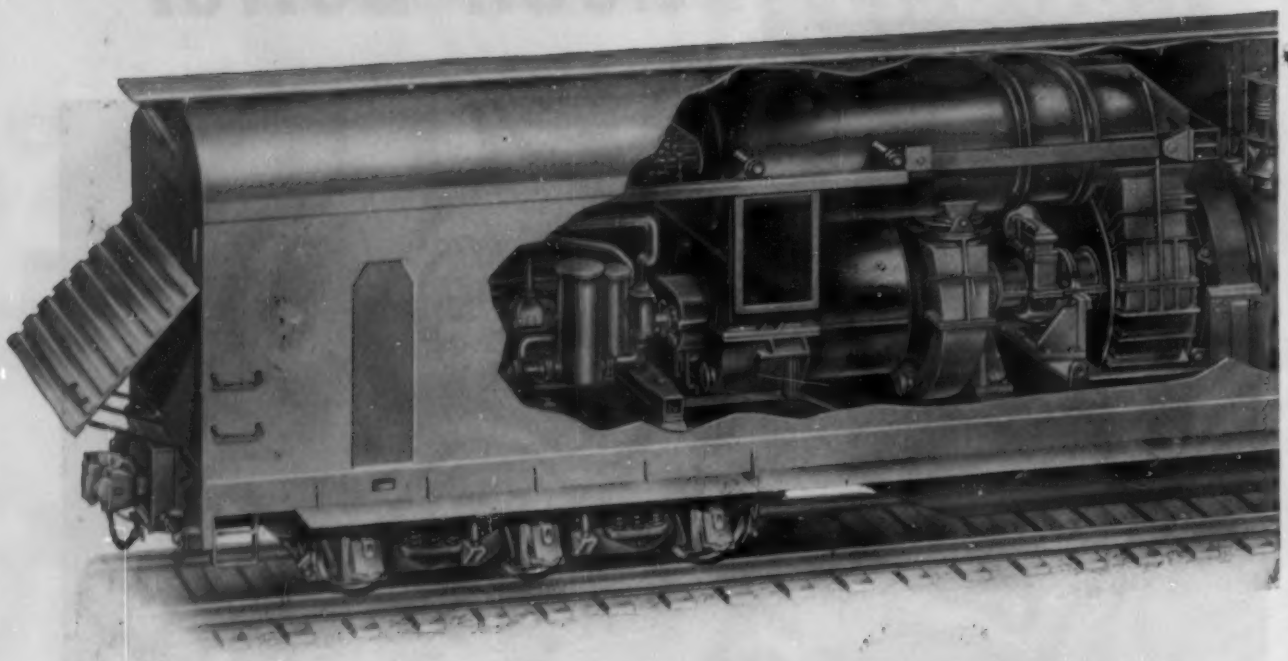
Vulcan Long Retracts clean better—with fewer outages, at lowest cost. They are engineered for optimum performance under varying conditions. They work equally well at any angle. They give you the benefit of dual-motor operation—one motor to traverse the lance, a second to rotate it. *Rotation is always in the same direction.* Repeated cleaning cycles result in an infinite number of double-helix paths that continually broaden the cleaning coverage. Lances can pass through as little as four inches of tube clearance. Write for Bulletin 1002.

COPES-VULCAN DIVISION

CONTINENTAL FOUNDRY & MACHINE COMPANY

ERIE 4, PENNSYLVANIA

Revolutionary Clark development in mobile power generation



A PACKAGED

KEY FEATURES

1 COMPLETELY SELF-CONTAINED
Requires only connection to fuel source and electrical load.
No water nor outside power needed.

2 ONE-MAN OPERATION
Simple, pneumatic controls. Complete, built-in, dead front switchgear.

3 MOVED AT HIGH SPEEDS
Can be hauled on regular passenger or freight train service. All components specifically designed for mobile operation. Special, heavy duty car.

4 QUICKLY PLACED IN SERVICE
No site preparation required. Operates on any reasonably level track.

5 3-POINT SUPPORT
Car flexing does not affect alignment of power unit.

6 DUAL FUEL OPERATION
Burns wide range of liquid or gaseous fuels simultaneously or individually.

7 SPLIT SHAFT DESIGN
No alignment problem. No step-down gears between turbine and load. No physical connection between turbines.

8 THERMO-ELASTIC DESIGN
Hot parts expand without stress. No bearing misalignment.

9 LONG LIFE — LOW TEMPERATURE
Minimum blade life of 100,000 hours.

10 AIR COOLED — NO WATER REQUIRED

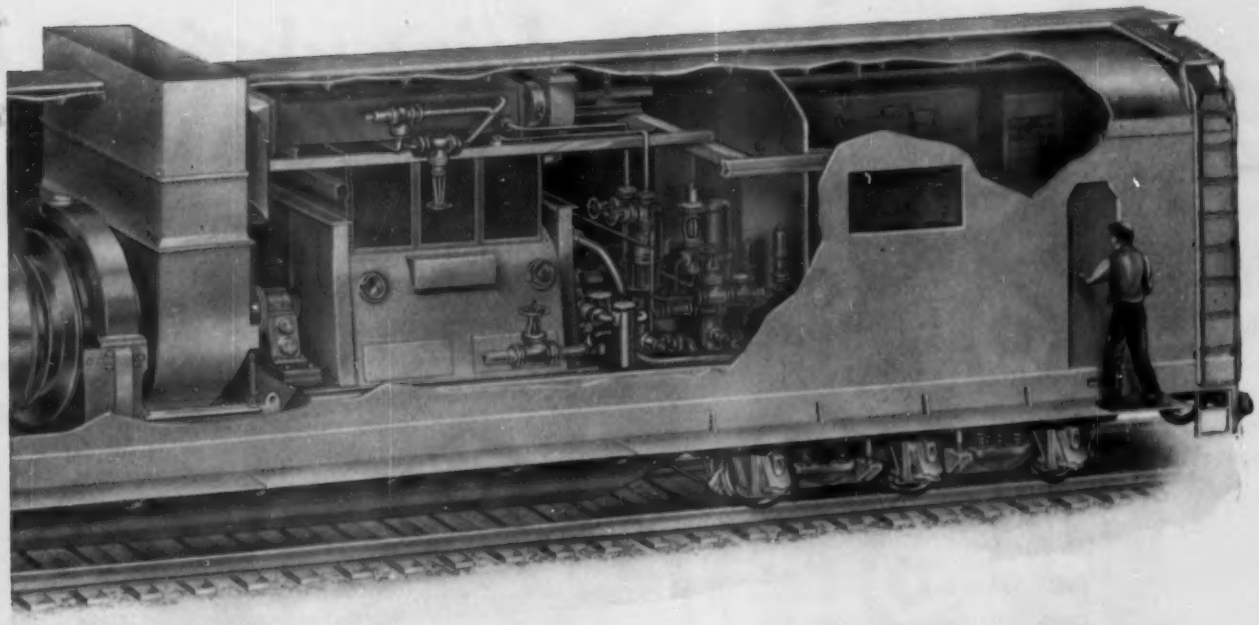
11 DUAL MULTI-STAGE HIGH AND LOW PRESSURE TURBINES

12 LIFETIME SINGLE COMBUSTION CHAMBER

13 MINIMUM RADIATION
All exposed surfaces cool enough to touch.

14 FLEXIBLE ELECTRICAL CHARACTERISTICS
Dual frequency. Operates in parallel with existing facilities or independently.

15 UNUSUAL ACCESSIBILITY
All parts readily accessible for rapid inspection and servicing.



5500 KW POWER PLANT

Completely self-contained in a single R.R. car

The Navy ordered it. Clark built it — a packaged 5500 KW mobile power plant completely self-contained in a single railroad car, for emergency use by the Bureau of Yards & Docks.

Featuring a completely new, Clark designed combustion gas turbine, driving a synchronous generator, the unit is specifically designed as a mobile emergency power station to supply a substantial block of power on short notice. Clearly, this is a development that offers many opportunities to the armed forces, civil defense, public utilities and industry.

Furthermore, the unique gas turbine which drives the generator is extremely well suited as a matching driver for centrifugal compressors serving the gas transmission, refining, process and other industries.

Clark engineers will gladly furnish details and discuss specific applications with you. Complete brochure mailed on request.

CLARK BROS. CO. • OLEAN, N. Y.

Offices in Principal Cities throughout the World

CLARK

ONE OF THE DRESSER INDUSTRIES

TURBINES
ENGINES
COMPRESSORS

Steam Generators of offer important savings

Advanced design features of Foster Wheeler "SC" Series Standard Steam Generators mean maximum economy of installation, operation and maintenance

FUELS: Oil or Gas
CAPACITIES: 50,000 to 150,000 lb/hr
STEAM PRESSURES: to 1500 psi
STEAM TEMPERATURES: Saturated to 950 F

The "SC" Series Standard Steam Generator is the latest development by Foster Wheeler toward the reduction of steam costs for manufacturing and process plants. Pre-engineered in all details and standardized for economy, the new units are available in nine sizes with maximum input of over 200 million Btu/hr.

Although dimensions and structural details are fixed, the design provides a wide choice of temperatures and pressures, 48" or 54" upper drums, balanced draft or pressurized firing, type and location of heat recovery equipment, fans and drive, and make of burners for oil or gas firing.

The advanced features of this design, some of which are noted below, contribute to low installation, operating and maintenance expense and maximum dependability under continuous, full-load operation.

1. **COMPLETELY WATER COOLED FURNACE** with 3" OD closely spaced tubes minimizes setting maintenance and prevents excessive exit gas temperatures.

2. **OVER 19 FOOT FIRING DEPTH** permits long horizontal flame travel with minimum of ineffective or unused furnace volume.

3. **FULLY DRAINABLE SUPERHEATER,** available when superheat is desired, simplifies operation and eliminates a potential trouble spot.

4. **STEAM PURIFYING SYSTEM** consisting of horizontal separators, chevron driers and dry box provides steam purity of less than 1 PPM.

5. **EFFICIENT CONVECTION SURFACE** of 2" OD tubes in a staggered, cross-flow arrangement, combines maximum heat transfer with minimum draft loss. Single-pass boiler section eliminates baffles, dead gas pockets, and further reduces maintenance and draft losses.

6. **UNRESTRICTED CIRCULATION** — Absence of headers provides free circulation through integral risers and downcomers, eliminates header handhole plates and gaskets as possible sources of leakage.

7. **FULL INSULATION** together with the relatively close spacing of the furnace tubes, results in low casing temperatures.

8. **BOTTOM SUPPORTED UNIT** fully utilizes the structural strength of the steel tubes and provides for free expansion of all pressure parts within a stationary casing. This provides low unit stresses in all members and results in a rugged structure that is economical to erect and install.

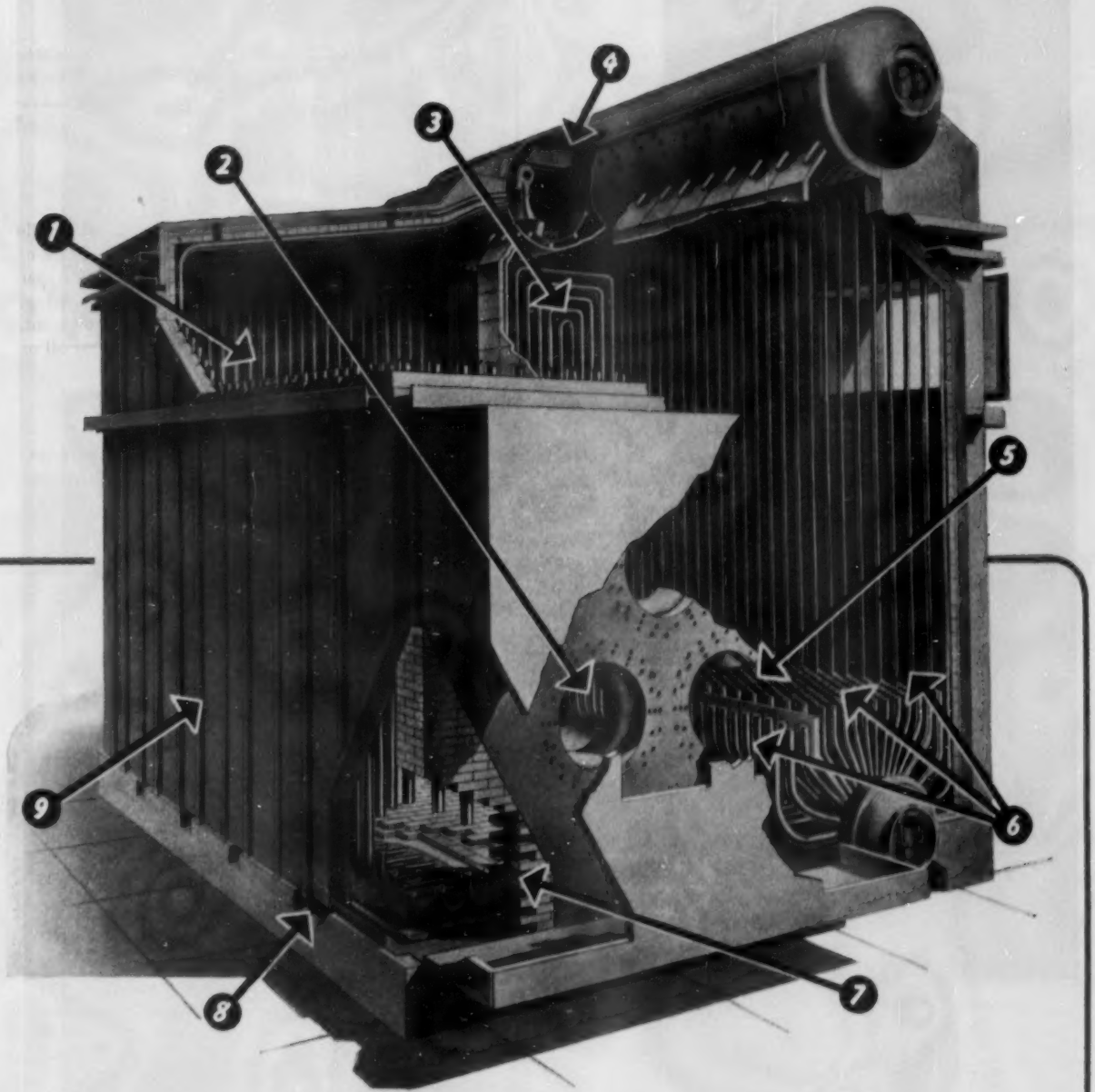
9. **ALL WELDED CASING** forms a rigid, pressure-tight unit. Possible sources of air and gas leakage are reduced to a minimum, thus providing lower operating costs through more efficient combustion.

LONDON • NEW YORK
PARIS • ST. CATHARINES, ONT.

FW FOSTER

STANDARD DESIGN

in industrial steam costs



WHEELER

FOR COMPLETE INFORMATION on the "SC" steam generators, write to *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

MOTOR CONTROL FACTS
ON INDUSTRY'S
MOST COMPLETE LINE

FACT: Here is industry's newest and most advanced high-voltage starter!

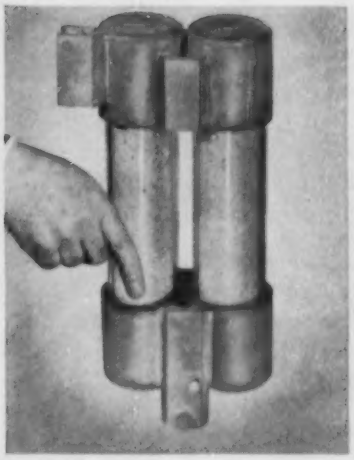
This new line of Westinghouse high-voltage fused starters offers industry more protection—more operating simplicity than any other. Here are a few reasons why:

Extension of the BAL fuse line up to 400 amperes with the first and only 400-ampere, double-barreled, single-unit fuse; a new 50,000-kva air break contactor featuring the most advanced arc interrupting action yet developed; and new enclosures providing new levels of convenience and safety.

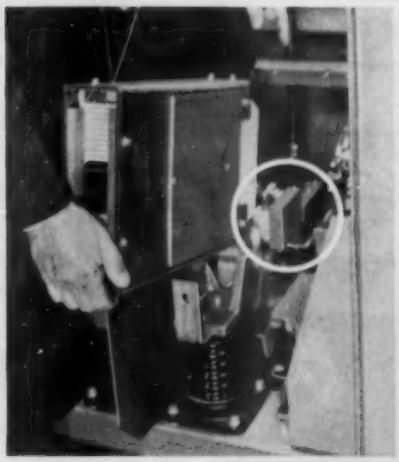
Booklet B-6535 has more facts on this outstanding new starter. Get it from your Westinghouse engineer—or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa.

J-21898

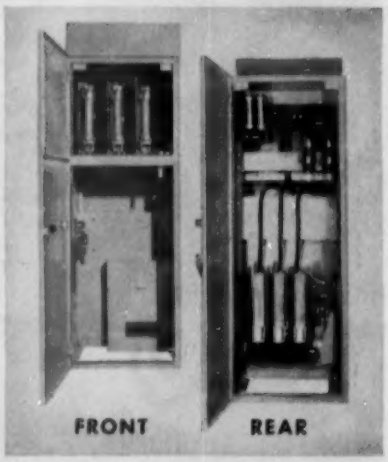
YOU CAN BE SURE... IF IT'S Westinghouse



New 400-ampere, double-barreled, type BAL fuse features "no-bolt" brazed connections which insure equal division of current. Complete coordination of fuses is assured. Exclusive BAL single-barreled design for fuses up to 200 amperes is retained.

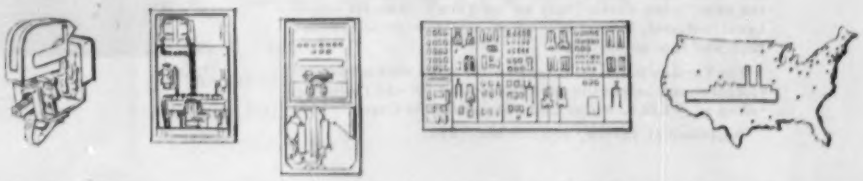


New air break contactor (200 and 400-ampere sizes) features a unique arc chute design which greatly simplifies inspection and maintenance of the contacts. Simply pull the arc chute down—contacts are immediately and conveniently accessible.



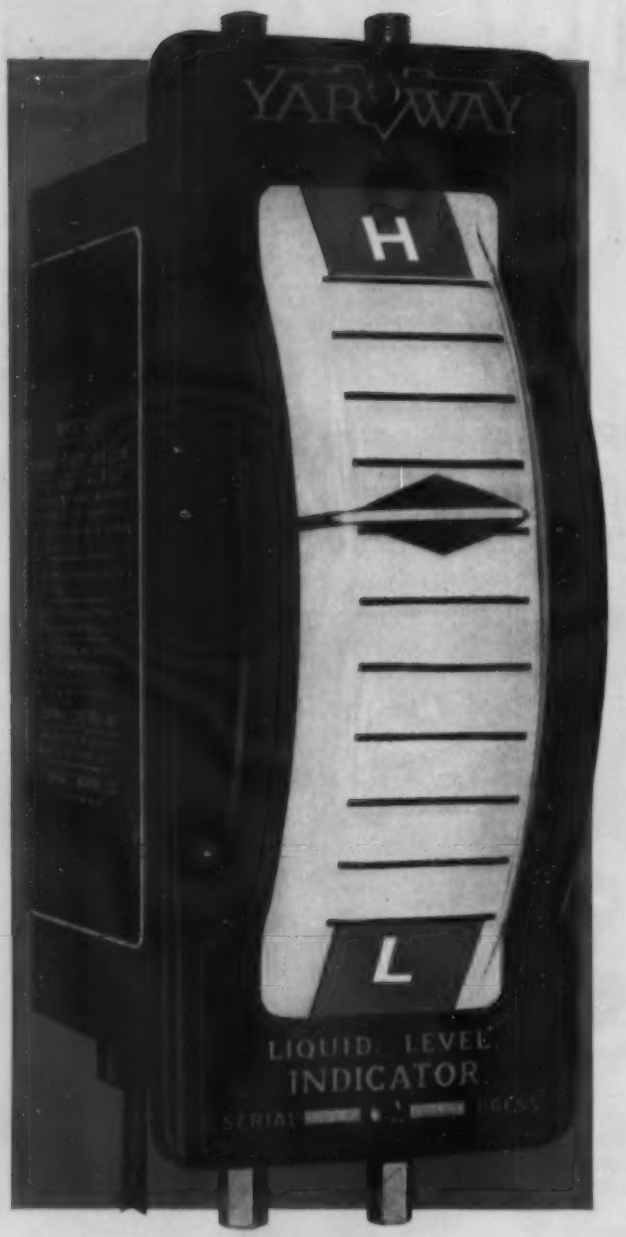
New enclosure design provides both mechanical and electrical interlocks; front and rear access DOORS; top-mounted bus arrangements; separate compartmentation of high and low-voltage components—all designed for maximum safety of personnel.

FROM INDUSTRY'S MOST COMPLETE LINE OF INDUSTRIAL CONTROL



CONTROL COMPONENTS • MOTOR CONTROL • ELECTRONIC CONTROL • CONTROL SYSTEMS • NATIONAL SERVICES

"this is



● Engineers tell us Yarway Remote Liquid Level Indicators are the most dependable boiler insurance they can have.

Instant . . . accurate . . . brilliant . . . continuous readings of boiler water level are seen on the panel or wherever you wish in your plant. You know the readings are right because they are controlled by the boiler water itself . . . by the pressure differential between a constant head of water and the varying head in the boiler drum. *Indicating mechanism is never under pressure.*

Yarway Indicators may be equipped with a Yarway Control Unit that operates Remote Hi-Lo-Alarm signal lights or horns. For a 24-hour record of boiler water levels, use the Yarway Hi-Lo-Graph Recorder.

On the boiler drum itself you'll want Yarway Water Gages . . . and these "bright as a star" gage readings can now be televised with a Yarway—RCA Television chain.

From drum to panel and at all remote locations, Yarway equipment gives you the safest boiler protection you can buy . . . proved beyond doubt in thousands of power plants.

Write for the specific bulletins you want.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

NEW! WIDER VISION!

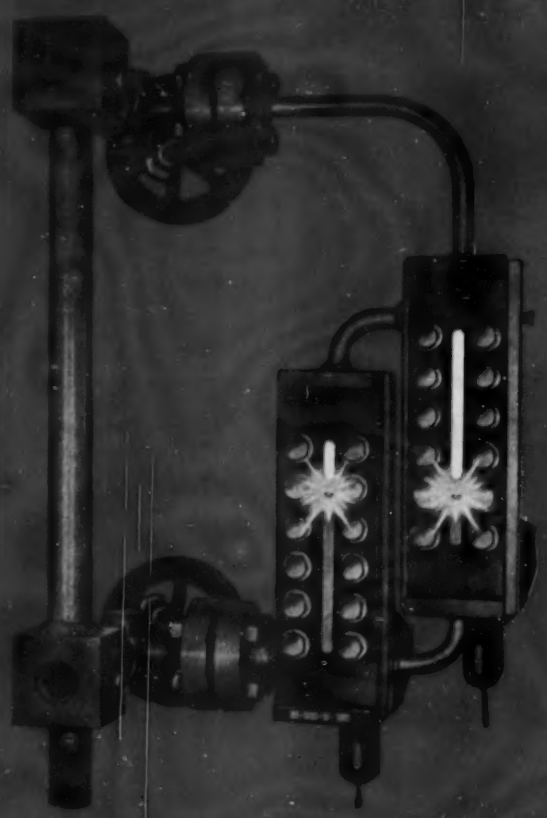
Clear, brilliant readings from any angle, are possible with the new "wide vision" face on the Yarway Remote Liquid Level Indicator. Pointer is always visible, even at extreme high and low water levels.

The Yarway Indicator is manometric type with automatic temperature compensation, as approved for use under the ruling of A.S.M.E. Boiler Code Committee in Case #1155.

Described in Yarway Bulletin WG-1824.

YARWAY

good boiler insurance!"



YARWAY WATER GAGES

Flat glass, high pressure type shown, features new separated-design insert and Type "M" illumination that causes water level meniscus to "shine like a star". Described in Yarway Bulletin WG-1812.

YARWAY REMOTE SIGNAL ALARMS

Lights or horns, operated by Control Unit on Yarway Indicator, give instant warning of any serious deviation from normal water level. Can be located anywhere in plant. Described in Yarway Bulletin WG-1824.

YARWAY HI-LO-GRAPH RECORDER

Gives a continuous 24-hour record of liquid levels. Actuating mechanism is same as in Yarway Indicator. Used both for indicating and recording. Described in Yarway Bulletin WG-1830.

YARWAY TELEVISION

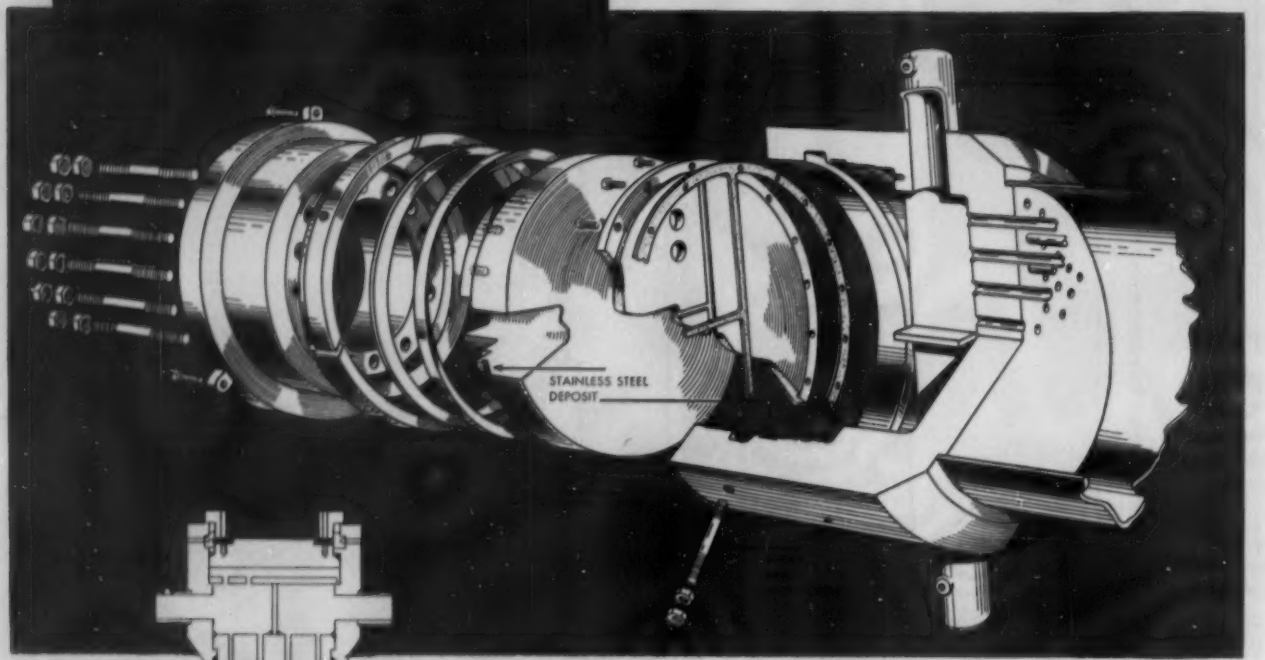
Simplified system consists of compact camera and panel-mounted monitor. Clear, bright image of water level gage anywhere in the plant.
Described in Yarway Bulletin WG-1813.

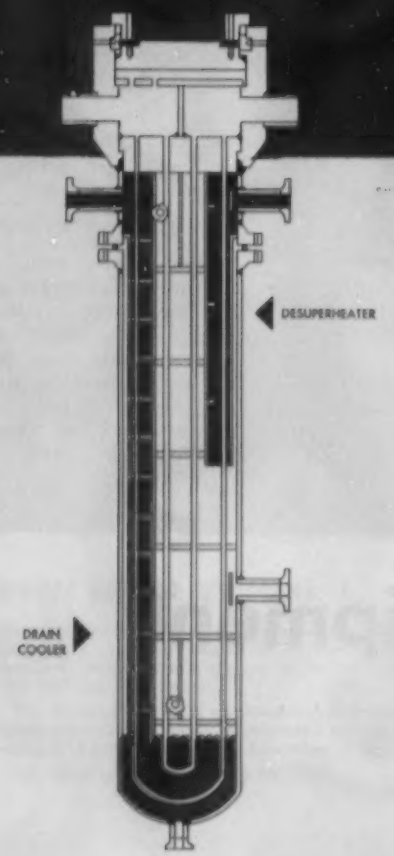
steam plant equipment

BLOW-OFF VALVES
WATER COLUMNS AND GAGES
LIQUID LEVEL INDICATORS
EXPANSION JOINTS
STEAM TRAPS
STRAINERS
SPRAY NOZZLES
DIGESTER VALVES

ATTENTION
POWER PLANT OPERATING ENGINEERS

see how feed water



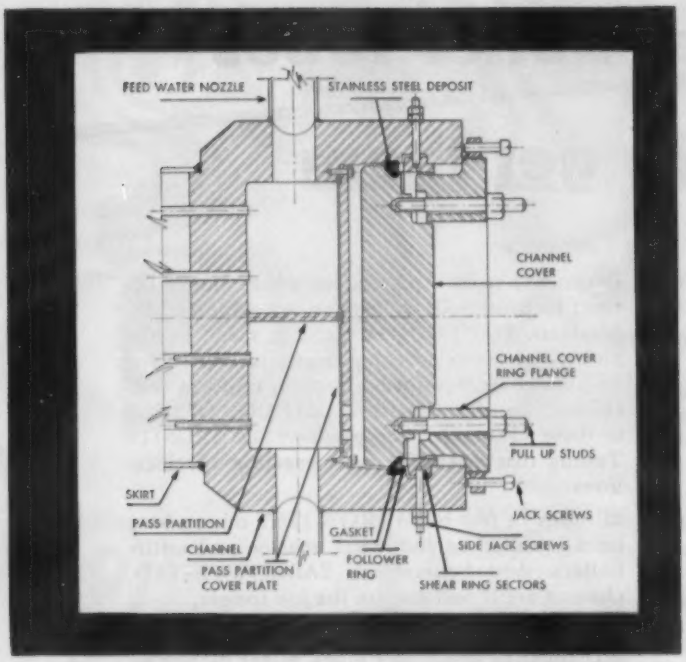


Exploded view and blueprint show construction detail of the unique closures exclusive with A. O. Smith feed water heaters. Cutaway drawing illustrates the closure as a part of the heater.

Note! In the A. O. Smith closure only one gasket is used. As a result, there's far less chance for leakage. Moreover, the closure is so designed that when pressure increases, sealing efficiency increases, too. Corrosion problems are eliminated by the fact that no mating surfaces are exposed to fluids and gasket contact areas on channel and channel cover are reinforced by stainless steel deposits. Overall construction is simple, thoroughly functional. What's more, A. O. Smith has the facilities and experience to build *standard* high-pressure closures.

Where conditions require, A. O. Smith feed water heaters can be supplied with desuperheating and drain-cooling shrouds for maximum efficiency.

A. O. Smith closure design cuts heater maintenance costs!



Pictured and described here are the closure features that help make A. O. Smith feed water heaters stand-out performers in power plant operation. Think of these features in terms of economy and in terms of years of continuous outage-free operation .

- **You get a positive seal from the start . . . the moment pressure bolting is tightened.**
- **Easy-in, easy-out. Design simplicity keeps closure assembly and disassembly down to 5 hours—less than a single shift.**
- **Parts are compact, easy to handle.**
- **Closures operate with one set of pressure bolting. Servicemen can get into the work quicker, easier.**
- **Closure gasket can be replaced without removing closure cover.**
- **No need to replace gasket after disassembling for maintenance.**

When it comes to feed water heaters, you'll profit most by contacting A. O. Smith first. Exchanger designs, proved through years of service, make specifications of 1,000 to 10,000 psi standard in our exchanger and vessel shops. Our thermal design group is widely recognized as one of America's finest. Write today for detailed information.

Through research . . . a better way

A.O.Smith
CORPORATION

PROCESS EQUIPMENT DIVISION
Milwaukee 1, Wisconsin

Chicago 4 • Cleveland 15 • Houston 2 • Los Angeles 22 • New York 17

International Division: Milwaukee 1, Wis.

ELECTRONIC FARROWTEST®

spots defects in welded steel boiler tubes

before you get them

Here's the last word in non-destructive tests for boiler tubes. It's FARROWTEST®, an electronic production method of checking tubing for irregularities.

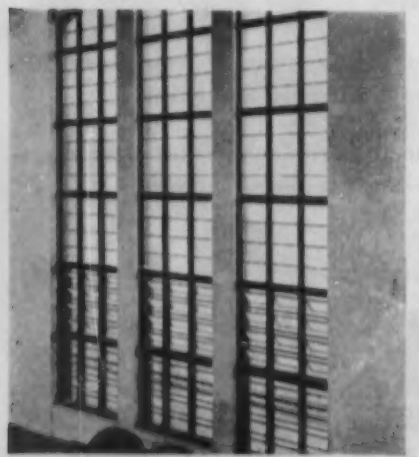
Republic Steel began developing this test in 1930, now has it available on the production line. You can specify it on ELECTRUNITE Pressure Tubing instead of your present method *at no extra cost.*

HERE'S HOW IT WORKS. Tube to be tested passes through a group of test coils. If the tube is uniform, the signal from the coils stays constant. When an injurious defect in the tube wall shows up, the tube stops moving automatically. An identifying mark is then put on the tube, and it is passed on to the reject rack.

WHAT IT MEANS TO YOU. Many tubing applications require testing beyond the normal non-destructive types. Applications where human life must be protected. Or expensive equipment. Or products. ELECTRUNITE Tubing, made by the electric resistance weld process, is known for its uniformity. Uniform strength, uniform wall thickness, uniform ductility. Add FARROWTEST to these advantages, and you have ELECTRUNITE Tubing that meets the most exacting specifications.

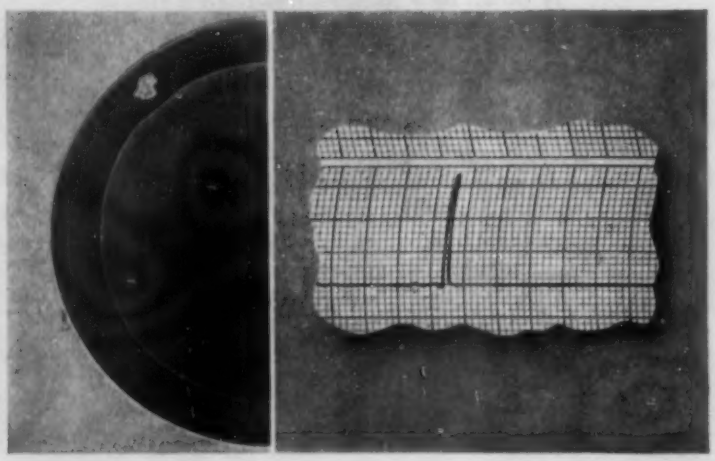
Millions of feet of FARROWTEST tubing have been installed in industrial, marine and utility boilers. And because it's FARROWTESTED, chances are it will stay on the job longer.

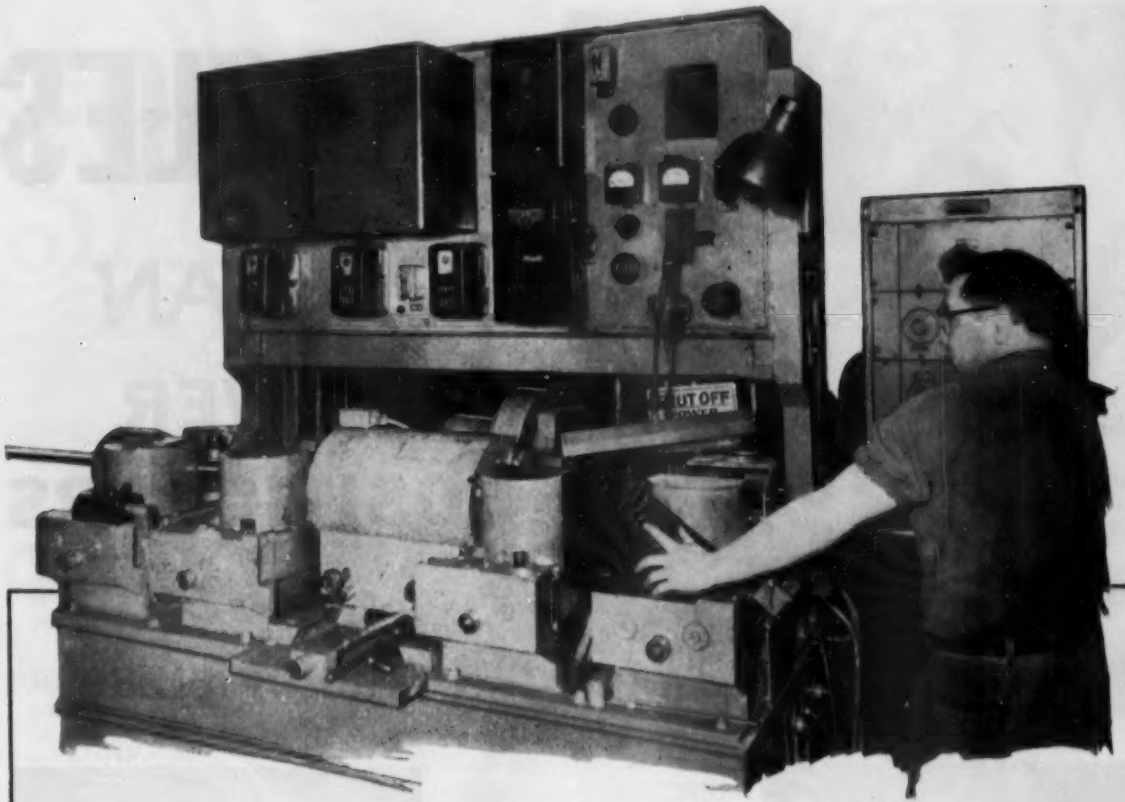
When you put in your next order for boiler, heat exchanger or condenser tubes, either carbon or stainless, specify FARROWTEST. *Remember, only Republic Steel offers you this electronic non-destructive test.*



Power plant equipment operating at high pressure creates special window problems. Windows must open and close rapidly to compensate for pressure variations. That's why this station is now equipped with Truscon Donovan Windows.

The FARROWTEST equipment automatically stopped when the defect shown in the micrograph (left below) passed through the detector coils. This defect was charted in the Oscillogram shown on the right.





TESTING METHODS

DESTRUCTIVE TESTING
- FLATTENING TEST
- FLANGE TEST
- EXPANSION TEST
- CRUSH TEST
- REVERSE BEND TEST

All these tests destroy tube.
These tests, properly made, eliminate to a very large degree the possibility of large or continuous defects.

NON-DESTRUCTIVE TESTING
- HYDROSTATIC TEST
- AIR TEST
- CO_2 GAS TEST
- FREON GAS TEST

These tests are for the purpose of picking up isolated steel or processing defects. All these methods of testing have some limiting factor as commercially applied.

FARROW TEST

The ultimate available today in electronic, non-destructive testing.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

REPUBLIC STEEL

REPUBLIC STEEL CORPORATION
3144 East 45th Street, Cleveland 27, Ohio

Please let me have more information on the following products:

- ☐ FARROWTEST
- ☐ ELECTRUNITE Boiler Tubes
- ☐ Truscon Steel Windows
- ☐ ELECTRUNITE Carbon Steel Heat Exchanger Tubes
- ☐ ELECTRUNITE Stainless Steel Heat Exchanger Tubes

Name_____ Title_____

Company_____

Address_____

City_____ State_____

K-7086

MUSCLES

HAGAN POWER POSITIONERS IN *FULL* RANGE OF SIZES!

6" x 10" Hagan Power Positioners operating inlet louvers to the forced draft fans for boilers of large power plant. (midwest climate)

10" x 30" counterweighted Hagan Power Positioner for 2500 pound slide type damper.

8" x 25" Hagan Power Positioner operating 54" butterfly valve, controlling flow of blast furnace gas to boiler. (Outdoor installation, note steam tracer lines)

FOR INDUSTRY

Hagan Power Positioners are rendering dependable, accurate service under the most severe operating conditions. These rugged, double acting units assure plenty of power, and are meeting high standards of accuracy for valve, damper and lever operating applications.

Low piston leakage, low piston friction and modest cost make Hagan Precision Positioners an economical buy.

CHECK THESE MANY OUTSTANDING FEATURES:

ACCURATE—piston takes a positive position for every incoming signal. Repeatability—1%.

HIGH SPEED—90% stroke in as little as 1.0 second.

FLEXIBLE—positioning is normally linear with signal pressure, but any desired relationship may be obtained by shaping the feedback cam.

INPUT SIGNAL RANGES—complete selection of ranges—3-15, 0-30, 0-60; others available.

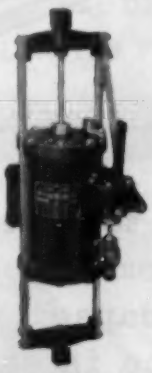
RUGGED CONSTRUCTION—insures dependable, long, trouble-free life.

FULL RANGE OF SIZES—4" to 12" bore—5" to 48" stroke. Full power for any need.

ACCESSORIES—Manual Operators—piston air locks—limit switches and many others.

4" x 5" HAGAN POWER POSITIONER

Stall torque—400 lb ft.*
90% full stroke—1 sec.
Specification Sheet TP-245



5" x 10" HAGAN POWER POSITIONER

Stall thrust—1950 lbs.*
90% full stroke—1.8 sec.
Specification Sheet TP-1510

8" x 14" HAGAN POWER POSITIONER

Stall torque—4600 lb ft.*
90% full stroke—2.5 sec.
Specification Sheet TP-2814

12" x 48" HAGAN POWER POSITIONER

Stall thrust—11,000 lbs.*
90% full stroke—6 sec.
Specification Sheet TP1100

*With 100 psi power air

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

HAGAN BUILDING • PITTSBURGH 30, PENNSYLVANIA

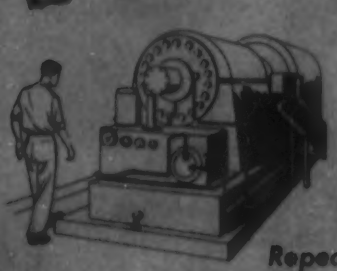
Metallurgical Furnace Control Systems • Boiler Combustion Control Systems • Ring Balance Flow and Pressure Instruments • Control Systems for Aeronautical and Automotive Testing Facilities

Facts* about

MEMO:
- of importance to Mechanical and Financial Engineers

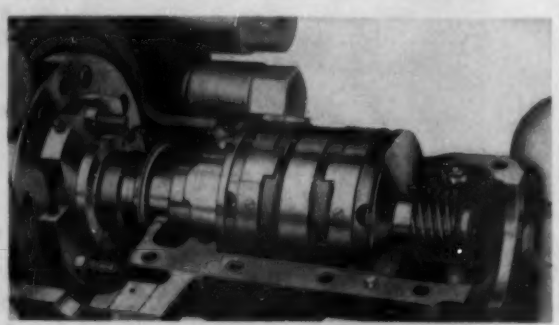
This plaque appears with increasing frequency in the Listing of Principal Power Plant Equipment...

MEMO:
- of importance to Operating and Maintenance Engineers



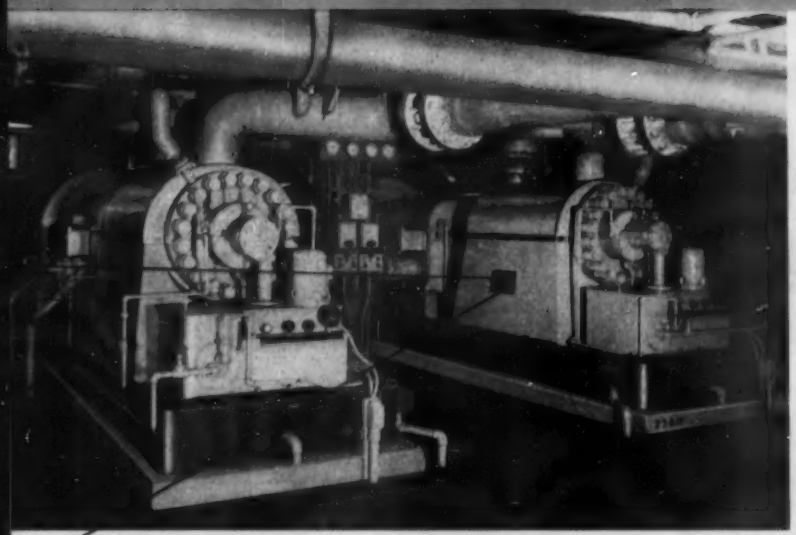
Your **PACIFIC BOILER FEED PUMPS** never need be dismantled unless there is a drop in capacity or head...then maintenance is easy...and because it is easy, the cost is low!

BEARINGS:
Can be inspected by simply removing the covers. Unitized internal assembly may be removed from the case and dismantled without heating the impellers or other parts.



Repeat orders from Utilities vary from 3 to 13 units—average 6 or more units!
Absolute evidence of Pacific's superiority in Performance—Economy—Service!

PACIFIC® BOILER FEED PUMPS



because it meets the Industry's 3 basic requirements... There is no cost compromise in the Design, Workmanship, Materials in

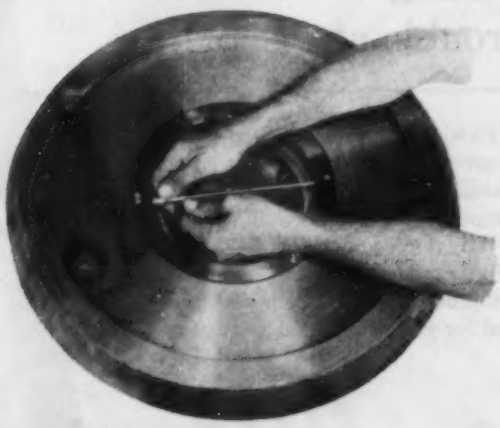
PACIFIC HIGH-PRESSURE BOILER-FEED PUMPS

● From 1950 to the present time more than 600 boiler feed pumps have been installed by Pacific for feedwater temperatures to 450° F ... capacities to one-million pounds-per-hour with discharge pressures to 2990 psig.

From the plain cylindrical case ... the unitized internal assembly ... the one, ring-type pressure joint ... the one, high pressure breakdown ... to bearings pressure lubricated with filtered, cooled oil, the design emphasizes simplicity with efficiency.

Precision workmanship is emphasized at every step from magniflux inspection of castings through boring ... turning ... grinding ... to dynamic balancing of rotating parts.

The chrome content of all parts fabricated from alloy steels is varied for depth hardening and resistance to corrosion-erosion.



MICROMETER CHECK-UP:

The accuracy of all internal bores can be checked *exactly*...not by guess...easily and quickly because of Pacific's superior design.

UNITIZED INTERNAL ASSEMBLY:

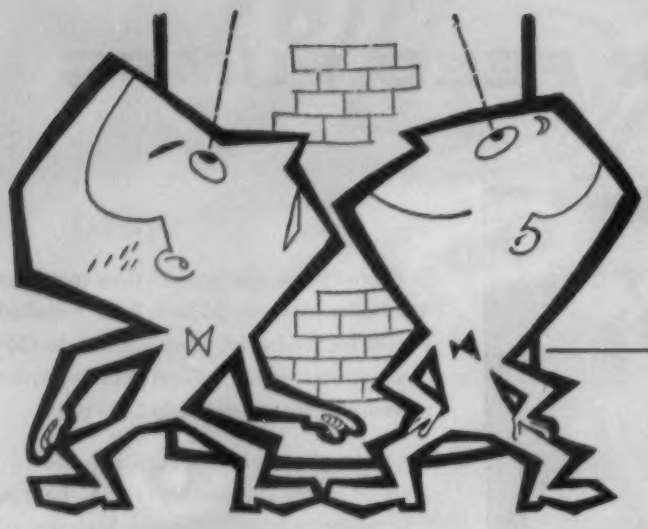
May be assembled by two men without the aid of a torch or other heating devices—thus eliminating shaft distortion due to uneven heating and cooling during assembly operation. There is no critical lateral adjustment of shaft after unitized internal assembly is installed in the case.

PACIFIC®

PACIFIC PUMPS INC. HUNTINGTON PARK CALIFORNIA

Export Office: Chanin Bldg., 122 E. 42nd St., N.Y.
Offices in all principal cities

BF-21

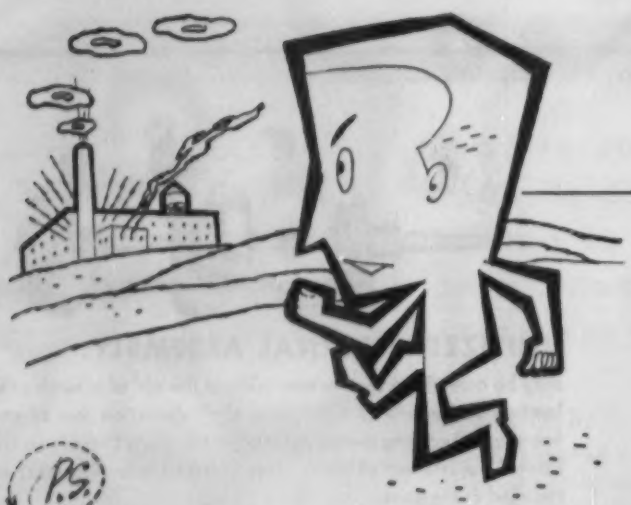


Your chimney never smokes any more. Did you change to another fuel?

We just changed to another kind of coal. And man! Does it make a difference! No smoke. No clinkers. No trouble. And very few ashes.

What kind of magic coal is this?

It's one of the superior quality coals produced on the Chesapeake and Ohio. But the important thing is that it is exactly right for our type of installation.



Say, I've got to look into this! We're always having boiler room trouble at our plant.

Picking the right coal is a job for an expert. I never realized there were so many things to consider. Size, moisture, sulphur, ash softening temperature, etc., as well as BTU's.

Why don't you write to the C&O coal people? Tell them your problem and describe your boiler equipment. They'll help you find the very best coal for your particular condition.

P.S.

There's a lot more to buying coal than the cost per ton. Why not contact coal producers on the C&O to solve your particular fuel requirements, or write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake and Ohio Railway Company, Terminal Tower, Cleveland 1, Ohio.

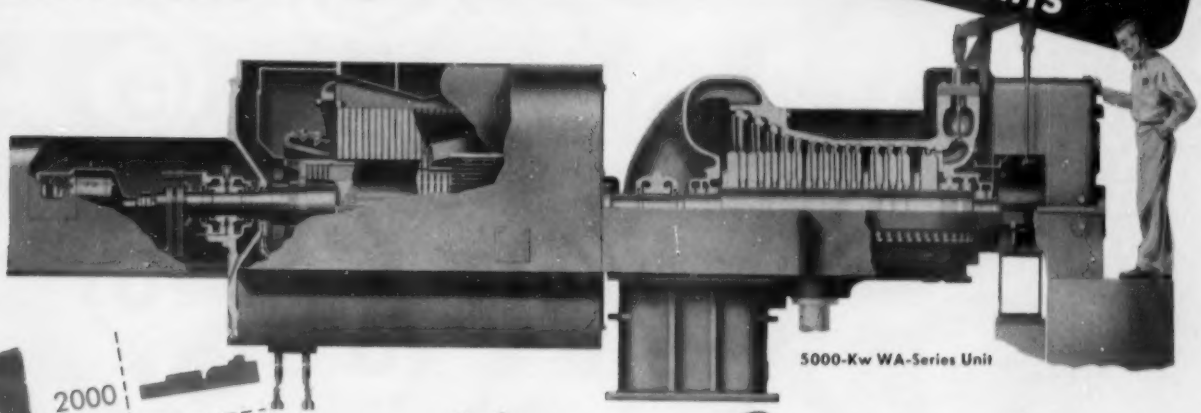
Chesapeake and Ohio Railway

WORLD'S LARGEST CARRIER OF BITUMINOUS COAL

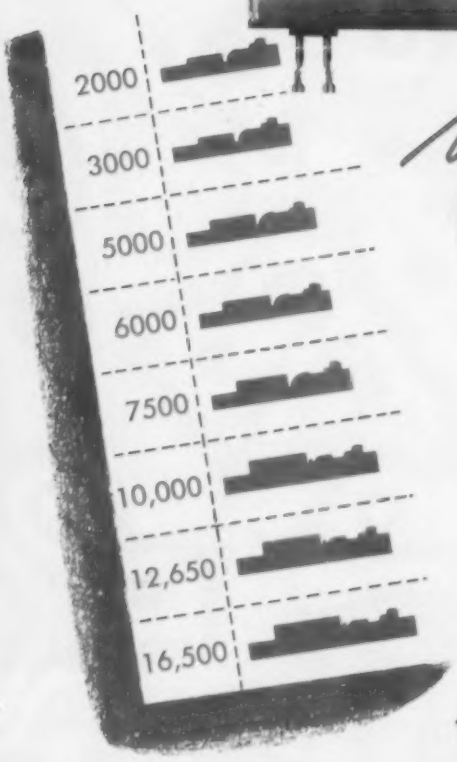
Now

WA-Series Extended To 16,500 Kw

WA-Series STEAM TURBINE GENERATOR UNITS



5000-Kw WA-Series Unit



Modern, Compact Units meet wider plant needs

Now you can get WA-Series steam turbine-generator units in new, higher ratings. Already operating across the country in NEMA ratings from 2000 to 7500 kw, these completely modern units are now available in AIEE-ASME preferred ratings to and including 16,500 kw.

WA-Series steam turbine-generator units provide power only or power as a by-product of process steam. They are attractive, compact units that have many of the "big turbine" features for which Allis-Chalmers is famous.

For example, the accurate, reliable centrifugal speed governor is the same type used in large Allis-Chalmers steam turbines. Steam seals are the same trouble-free labyrinth type used in turbines up to 300,000 kw.

For information on application of these modern, economical generating units, turn the page.

A-4810

ALLIS-CHALMERS

For Modern Power

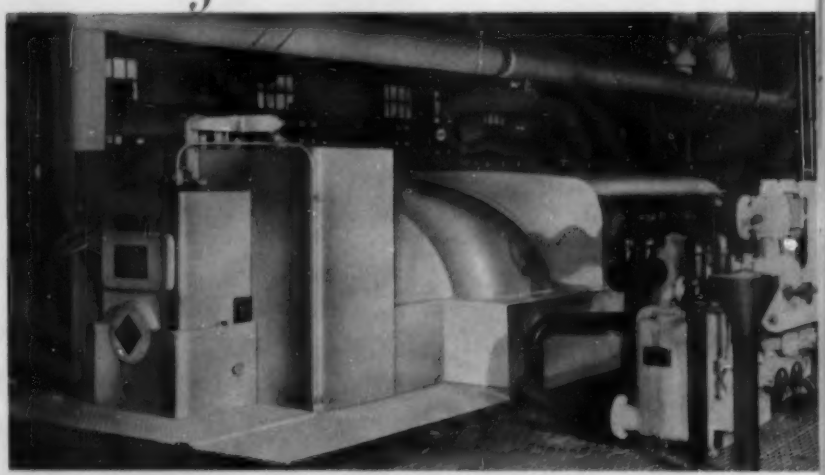
MANUFACTURING PLANT in Wisconsin uses this 7500-kw automatic extraction condensing unit in its power house. WA-Series unit generates power as by-product of process steam.

MINING OPERATION in Southwest gets power from a 5000-kw condensing unit. Waste heat from reverberatory furnaces is used for generating steam.

PAPER MILL in Wisconsin uses this 5000-kw non-condensing WA-Series unit to obtain both power and process steam for paper manufacturing. Photo at right shows generator end of unit.

UTILITY SERVICE in Ohio is provided by 3000-kw condensing WA-Series steam turbine generating unit.

WA-Series
STEAM TURBINE GENERATOR UNITS



ALLIS-

Plants Everywhere

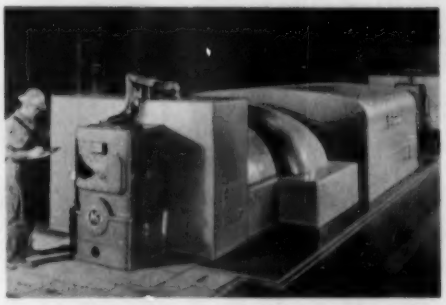
● Installations throughout the country are proving the low installation and operating costs of modern WA-Series steam turbine-generator units.

Maximum simplicity is assured by three-bearing construction. A bracket-bearing, housing type air-cooled generator is used for smaller units. A hydrogen-cooled generator is used for 16,500-kw units. Basic engineering features include labyrinth steam seals throughout, removable external glands, high chrome alloy steel buckets and nozzles and a time-proved governing system.

Installation is simplified because WA-Series units are factory assembled, and shipped on a single flatcar. Turbine and generator rotors are individually locked securely in place. All manufacturing and testing takes place in a single plant.

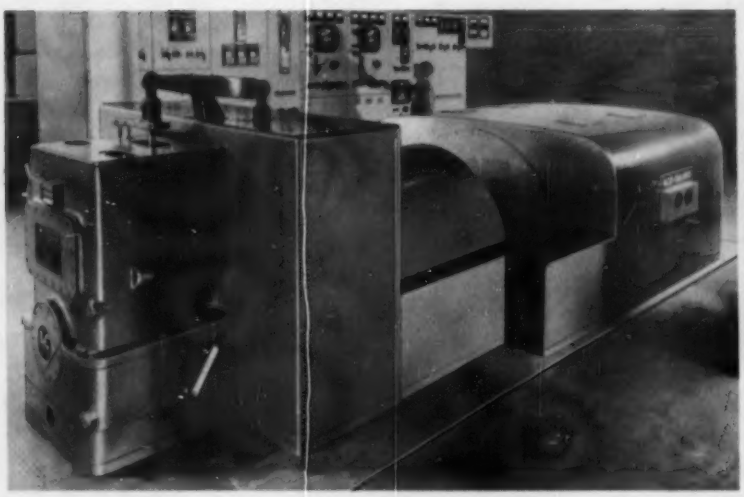
Foundation cost is reduced because oil piping and generator air coolers are above the floor line.

To get more facts on these economical units, call the nearest A-C district office or write Allis-Chalmers, Milwaukee 1, Wisconsin for Bulletin 03B7654.

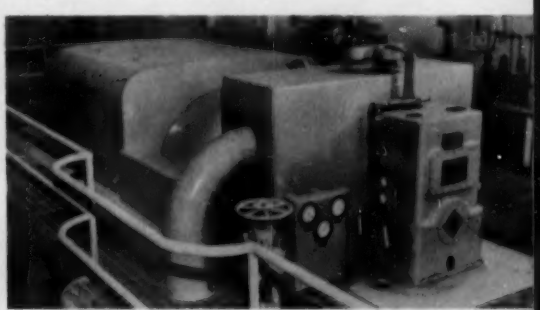


CHEMICAL OPERATION in Illinois uses two 5000-kw automatic extraction condensing units which generate power as by-product of process steam needs.

UTILITY in Florida uses two 5000-kw condensing WA-Series units to supply power for consumer needs.



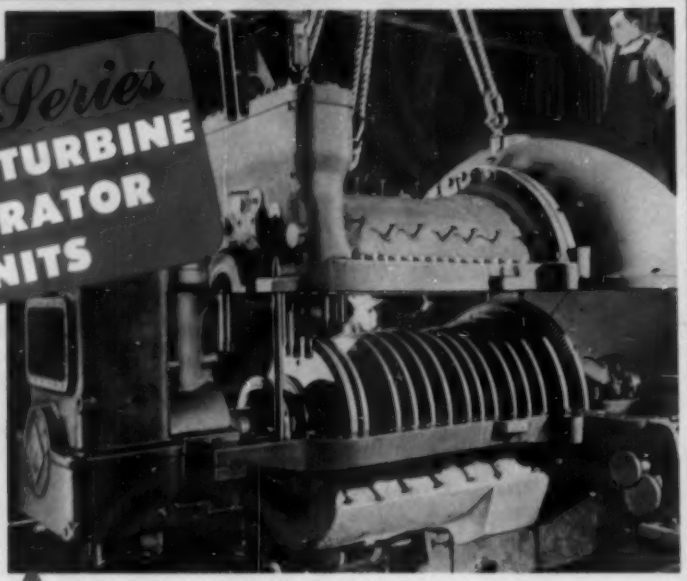
GRAIN PROCESSING in Wisconsin requires power and vast quantities of process steam 24 hours a day, 7 days a week. A 2500-kw non-condensing unit supplies power as by-product from process steam.



CEMENT PLANT in Kentucky obtains electric power from a 5000-kw condensing WA-Series unit. Steam is produced with waste heat from kilns.

CHALMERS

A-C ALLIS-CHALMERS



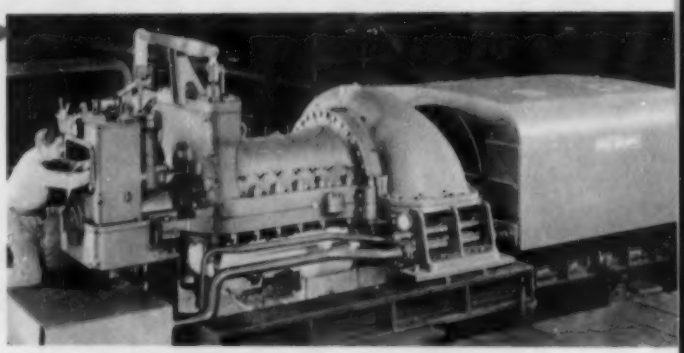
WA-Series STEAM TURBINE GENERATOR UNITS

▲ Above: Precision balanced turbine rotor is lowered into casing during manufacture of a WA-Series steam turbine generator unit. One example of the quality designed into these units: all wheels have durable chrome alloy steel buckets.

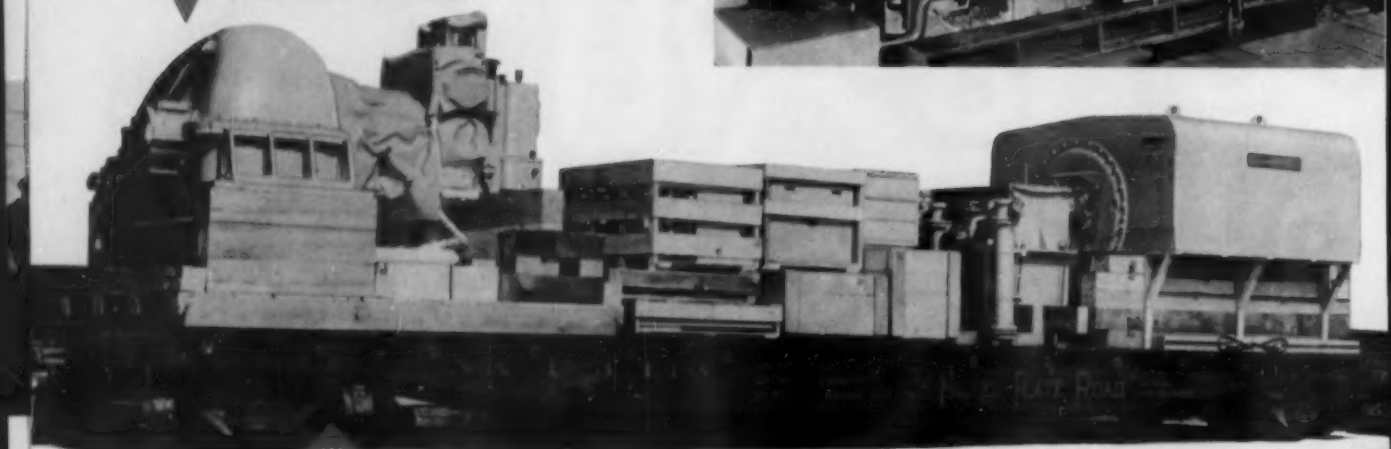
▲ Next step in assembly is addition of upper half of the turbine casing. WA-Series units provide the benefits of more than 50 years of Allis-Chalmers experience in designing and manufacturing steam turbine generating equipment.

Precision Built
For Fast Installation

Assembled 3-bearing unit—complete with housing type generator — is factory tested. Both oil piping and generator gas coolers are above the floor line, simplifying installation and service.



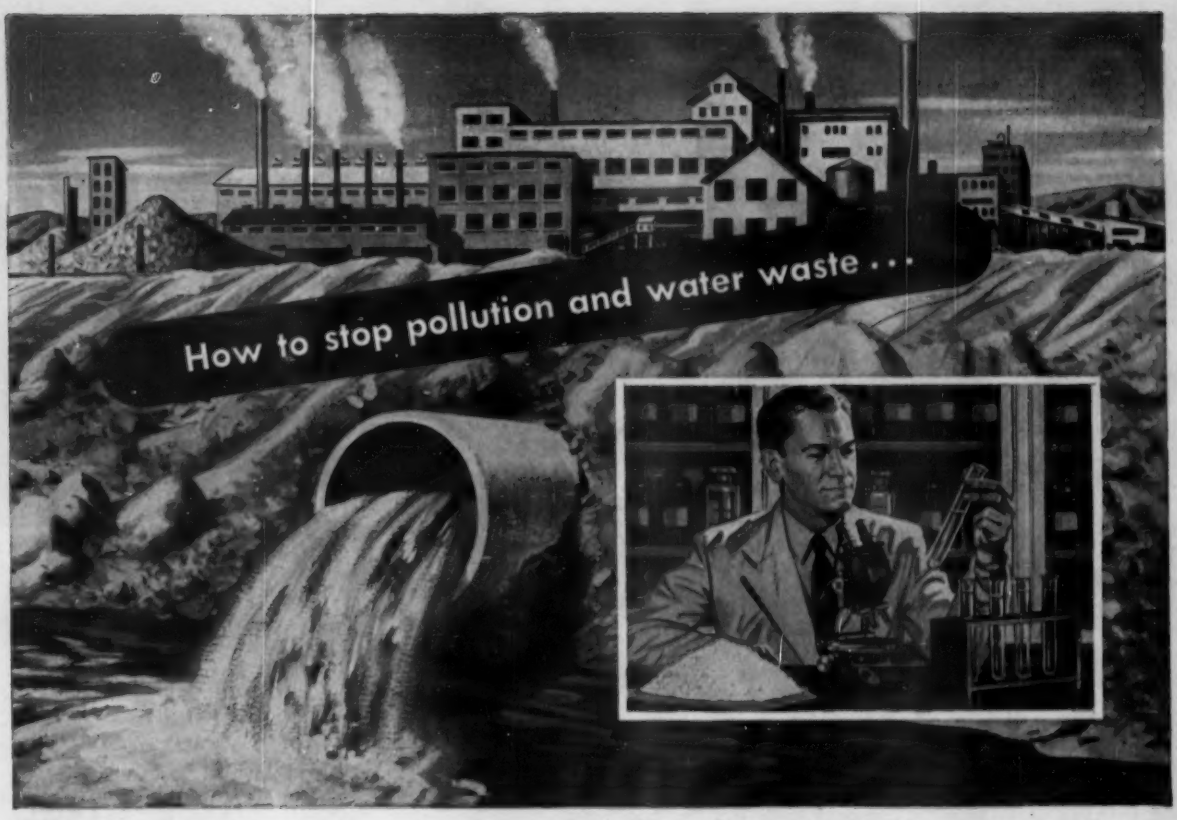
An entire WA-Series unit—pretested and insulated—is loaded on a single flatcar for shipment. Both turbine and generator are shipped with their rotors locked securely in place. Below, a 7500-kw unit in transit.



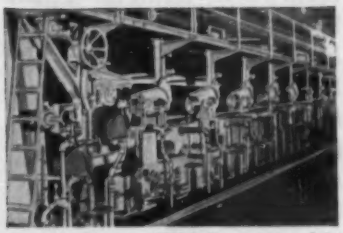
A-C ALLIS-CHALMERS

ALLIS-CHALMERS

Milwaukee 1, Wisconsin



CELITE FILTRATION removes harmful impurities and purifies water for re-use



In paper plants "White" water used in paper formation is purified for re-use by Celite Filtration. The Celite method can also provide clean pure process water in many other industrial uses—for boiler make-up, heat exchangers, circulating water for towers, etc.

In oil wells—output is boosted by re-pressurizing wells with water to force out accumulated oil. Celite Filtration purifies water to the extreme degree required—removes the minute suspended impurities which would otherwise clog the microscopic pores of sandstone.

CELITE* FILTRATION can reduce your process water costs materially—and it can greatly aid your community's water conservation and anti-pollution program.

If your plant now discharges industrial water as waste, Celite Filtration enables you to purify this water for *re-use*—at relatively low cost. Celite removes all types of suspended solids. When required, it even filters out fine matter such as amoebae and algae, many of which cannot be removed by other methods. Thus by recycling process water you can save on water costs . . . and save your community's water.

At such times as you still find it necessary to discharge process water, Celite Filtration is an important anti-polution measure. It helps make water safe and harmless . . . thereby protecting your community's recreational areas, fish and wildlife.

Food processors, beverage manufacturers, swimming pool operators and many industrial users of process water depend on Celite Filtration.

It will pay you to investigate the unique advantages of Celite for your particular application. Celite itself is carefully processed from the purest deposits of diatomaceous earth. It comes in nine standard grades, and you are always assured of utmost uniformity of product. To have a Celite engineer study your problem and offer recommendations, simply write Johns-Manville, Box 60, New York 16, New York. In Canada, 199 Bay Street, Toronto 1, Ontario. *T.M. Reg. U.S. Pat. Off.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CELITE FILTER AIDS

These Industrial of Detroit

OF VARIOUS TYPES AND CAPACITIES ARE TYPICAL OF THOUSANDS OF CUSTOMERS. SUCH UNIVERSAL ACCEPTANCE... AND THE LARGE NUMBER OF REPEAT ORDERS ... ARE OVERWHELMING EVIDENCE OF SATISFACTION.

Aluminum Co. of America—9 plants
Allied Chemical & Dye Corp.—4 plants
Abitibi Power & Paper Co. Ltd.—2 plants
Amalgamated Sugar Co.—3 plants
American Crystal Sugar Co.—3 plants
American Steel Foundries
American Tobacco Co.—2 plants
Armour & Co.—4 plants
The Borden Co.—28 plants
Burroughs Adding Mach. Co.—2 plants
Cannon Mills Inc.—10 plants
The Carborundum Co.—3 plants
J. I. Case Co.—5 plants
Chesapeake & Ohio Ry. Co.—7 plants
C. B. & Q. R. R. Co.—4 plants
Chicago & Northwestern R. R.—3 plants
Chrysler Corporation—12 plants
Columbian Carbon Co.—3 plants
Peter Cooper Corporations—4 plants
Crane Co.
Avco Mfg. Corp.
Crosley Division—2 plants
Crosse & Blackwell Co.—2 plants
Crucible Steel Co. of America—2 plants
Cudahy Bros. Co.
Deere & Co.—6 plants
E. I. Dupont de Nemours & Co.—9 plants
The Electric Autolite Co.—14 plants
The Falk Corp.
Firestone Tire & Rubber Co.—6 plants
General Electric Co.—6 plants
General Foods Corp.—3 plants
General Motors Corporation—37 plants
Goodyear Tire & Rubber Co.
Great Lakes Sugar Co.—3 plants
Great Western Sugar Co.—3 plants
Hercules Powder Co.—4 plants
Homestake Mining Co.—9 plants
International Harvester Co.—2 plants
International Shoe Co.—17 plants
Jones & Laughlin Steel Corp.
Spencer Kellog & Sons Inc.—6 plants
Koppers Co. Inc.—2 plants
Lever Bros. Ltd.
Libby, McNeill & Libby—3 plants
Libbey-Owens-Ford Glass Co.—3 plants
Liggett & Meyers Tobacco Co.—2 plants
Eli Lilly & Co.—2 plants
Marshall Field & Co.—3 plants
Michigan Sugar Co.—6 plants
Minnesota Mining & Mfg. Co.—4 plants
Minneapolis-Moline Co.—2 plants
Monsanto Chemical Co.—3 plants
Nash-Kelvinator Corp.—2 plants
National Dairy Prod. Corp.—12 plants
Nestle Co., Inc.—4 plants
New York Central System—14 plants
Pacific Mills—3 plants
Pittsburgh Plate Glass Co.—3 plants
Pullman Inc.—5 plants

WHY NOT LET US REDUCE YOUR STEAM COST?

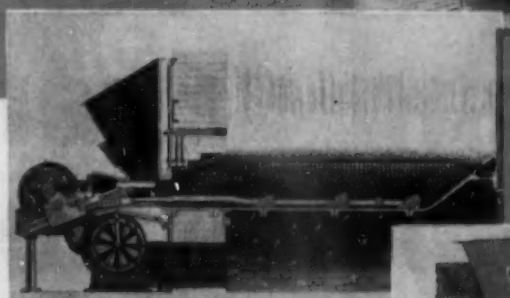
An informal discussion with one of our Engineers will cost you nothing and might save you a lot. Write us today.

DETROIT SINCE 1898 STOKERS

Users Stokers

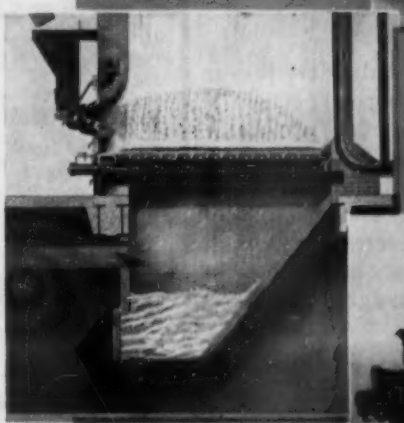
THERE IS A TYPE AND SIZE OF DETROIT STOKER FOR EVERY INDUSTRIAL NEED

LOSTOKER—Single retort underfeed, with Adjustable Feed—great coal saver for small boilers. ▶



UNISTOKER with Adjustable Feed. Compact unit type. Fan and motor, conveniently mounted at front. Automatically controlled. ◀

DOUBLE RETORT STOKER—A Multiple retort, side cleaning stoker with Adjustable coal feed control. ▶



ROTOSTOKER—Spreader stoker with overthrow rotors—Burns wide range of fuel—Handles fluctuating loads—Dumping, or stationary grate types. ◀

ROTOGRATE STOKER—Improved spreader stoker with grates that continuously discharge the ash at the front—Permits high burning rates per square foot of grate.

Quaker Oats Co.
Ralston Purina Co.—11 plants
Republic Steel Corp.—2 plants
Rochester & Pittsburgh Coal Co.
Shepard Niles Crane & Hoist Corp.
Square D Co.
Stromberg-Carlson Co.
The Studebaker Corp.—3 plants
Swift & Co.—18 plants
Tennessee Coal, Iron & R. R. Co.
Tennessee Eastman Co.
Union Carbide & Carbon—3 plants
United States Gypsum Co.—4 plants
United States Leather Co.—5 plants
Walworth Co.—2 plants
W. Va. Pulp & Paper Co.—2 plants
Western Electric Co. Inc.
Wilson & Co.—8 plants
Worthington Pump—2 plants
Rudolph Wurlitzer Co.—2 plants
Wyman Gordon Co.
Willys-Overland Motors, Inc.

Automotive Manufacturing—
112 plants

DETROIT STOKER COMPANY

GENERAL MOTORS BLDG., DETROIT 2, MICH.

Works at Monroe, Mich. • District Offices in Principal Cities

SAVE MONEY AND PROTECT YOUR PLANT BY

Installing Hancock 1500# and 2500# Steel Valves and assuring dependable leak-proof service

Put an end to the costly hazards of valve leakage in your high-pressure, high-temperature steam plant! Let proved-in-the-line Hancock 1500# and 2500# Valves assure the safe, reliable performance so essential to protect personnel, plant and service to customers.

Hancock 1500# and 2500# Steel Valves are preferred by most design and operating engineers in modern steam plants for very practical reasons. There is no bonnet joint to leak, no gasket to leak, no seat insert to leak! In fact, these rugged valves have every design, quality and construction feature essential for the severest services. Get complete information, then try one of these heavy-duty valves. You will soon agree that . . .

When Hancocks go in, valve costs go down!

SIZES:

¼" through 2"
Outside Screw
and Yoke

SERVICE RATINGS:

Screwed and Socket Weld Ends: For all pressures up to 2500 psi at 1050° F., O.W.G. 6000 psi—100° F.

Flanged Ends: For all pressures up to 1500 psi at 900° F., O.W.G. 3600 psi—100° F.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR is as close as your telephone. You can depend on his recommendations and service to save you time, trouble and expense.

In Canada: *Manning, Maxwell & Moore of Canada Ltd., Galt, Ontario*

HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** Watertown 72, Massachusetts

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, Stratford, Conn. 'CONSOLIDATED' SAFETY RELIEF VALVES, Tulsa, Okla. AIRCRAFT CONTROL PRODUCTS, Danbury, Conn. and Inglewood, Calif. "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, Muskegon, Mich.

How Grid-Type Phase Control IMPROVES RECTIFIER OPERATION

Separate circuits — one for firing, one for phase control — give important operating advantages in excitron rectifiers. The excitation circuit maintains a continuous arc that makes the excitron rectifier much less likely than other types to lose excitation during operation. A separate circuit utilizes the deionizing grid to obtain phase control.

Only excitron rectifiers provide separation of these two functions in separate circuits. Improved operation is the result, because one function is never sacrificed to the other — you get optimum operation from each.

Grid-type phase control permits operation in the clean region near the anode where ion density is lowest, instead of on the surface of the cathode mercury pool where the mercury may be contaminated. Reliability of phase control does not depend on the condition of the mercury. Only excitron rectifiers can give you this important operating advantage.

For more information on grid-type phase control of excitron rectifiers, consult the A-C office nearest you or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-4822

ALLIS-CHALMERS

Controlling Cyclones Electronically

CONTROL OF OVER 130 BOILER FUNCTIONS

at Ridgeland is centralized on these Republic electronic benchboards.

RIDGELAND STATION
Stickney, Illinois
Units 1 and 2 consist of four superheat coal and gas fired boilers operating at 1800 psi and 1050°F. Units 3 and 4 consist of two coal fired reheat boilers operating at 1900 psi and 1050°F/1000°F.
Sargent and Lundy, Consulting Engineers

at RIDGELAND

Commonwealth Edison's Ridgeland Station near Chicago is the largest completely cyclone-fired power plant in the world. A total of 28 cyclone furnaces fire the plant's six boilers which together can generate enough steam to supply four turbine-generator units with a net capability of 640,000 kilowatts.

To maintain maximum firing efficiency, combustion conditions at each cyclone are individually controlled and integrated with over-all plant operation by a Republic Electronic Combustion Control System. The system provides separate controls for primary air, secondary air, fuel feed and fuel-air ratio at each of the 28 cyclone furnaces in addition to controlling forced and induced draft fans and feedwater pumps on each boiler. All told, there are more than 130 individual controls which are automatically coordinated for continuous proper combustion.

Republic Electronic Controls handle all of these functions without introducing transmission lags, complicated pneumatic-mechanical linkages and inaccuracies due to mechanical inertia into the control system. Intergration of control information is greatly simplified by the use of electronic circuits. Expensive panel piping is eliminated and control panels are easier to operate. Because transmission of control impulses is electrical, all parts of the control system can respond simultaneously for smooth, coordinated operation of the boilers.

Ridgeland is but one of many modern cyclone-fired power plants that are equipped with Republic Combustion Controls. In fact, more cyclones are controlled by Republic than by any other make of controls.

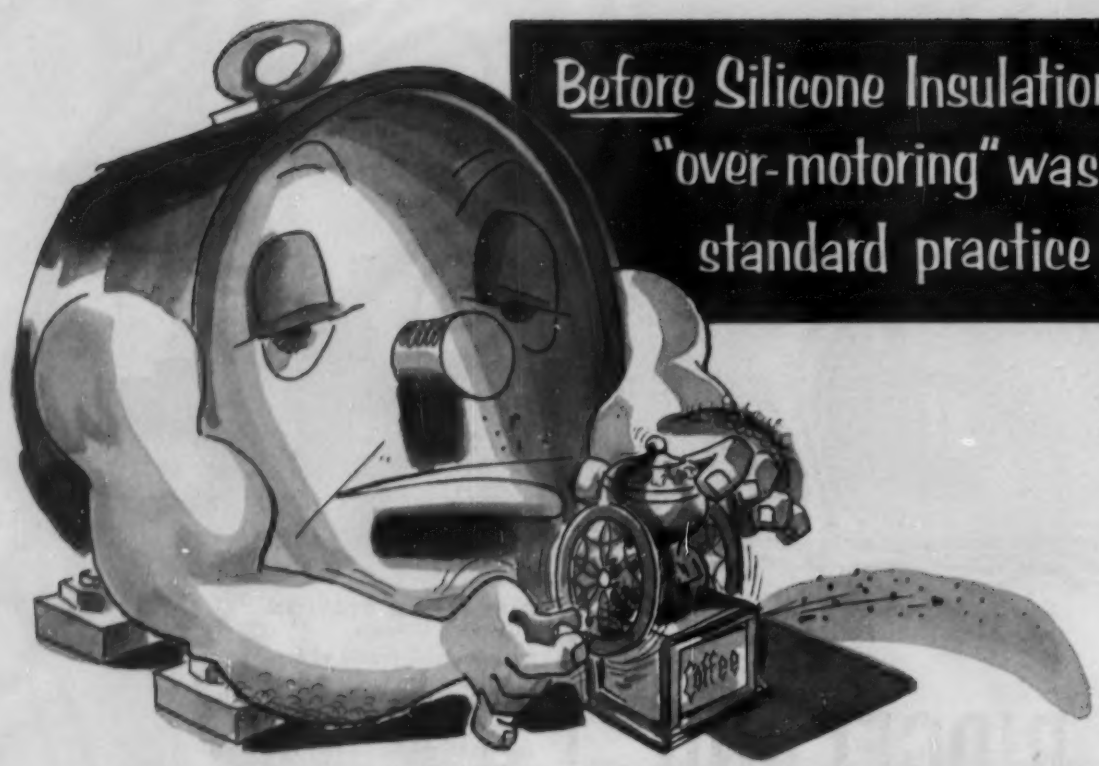
Where new developments such as cyclone furnaces call for new control techniques, you'll find Republic engineers and modern Republic equipment up to the task of devising combustion control systems that will meet the requirements of maximum efficiency, dependability and easy operation.

Write us when your problem is combustion controls.

REPUBLIC Automatic
COMBUSTION CONTROLS
(pneumatic or electric)

- **FOR ALL SIZES AND TYPES OF BOILERS**
- **FOR ALL METHODS OF FUEL FIRING**
- **FOR ALL LOAD CONDITIONS**
- **FOR ALL ARRANGEMENTS OF DRAFT**

REPUBLIC FLOW METERS CO. • 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS



Before Silicone Insulation, "over-motoring" was standard practice!

...but now you can match the load; let silicones carry the overload!

Overload capacity ranges up to 50% for Class H compared with 15% for comparable Class A motors.

that means

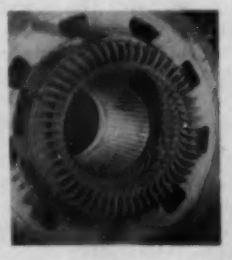
- ***more efficient use of motors.*** You can use the service factor built into silicone insulated motors to carry most initial or intermittent overloads or loads that can't be matched in standard frame sizes.
- ***smaller motors*** that require less magnetizing current and give you better power factor than ordinary motors of the same hp rating, because silicone insulation permits higher operating temperatures.
- ***more continuous production.*** Motor failure . . . down time . . . repair and replacement costs are reduced by *built-in* overload capacity and superior resistance to corrosive or abrasive atmospheres, high ambient temperatures and moisture.

Remember over-motoring is outmoded

For instance—

Allis-Chalmers gives you maximum overload capacity and maximum resistance to abrasion, moisture, vibration and to both electrical and mechanical fatigue in "Silco-Flex" insulated motors.

The Allis-Chalmers all silicone rubber insulating system made with Silastic*, is now available in most motors of 500 hp and larger. They offer longer life and more economical operation under severe operating conditions in power plants and mines, and in such continuous process industries as cement, chemical, food, paper and rubber manufacturing.



Dow Corning Corporation, Dept. 6910, Midland, Mich.

Please send me sources of supply for new Silicone (Class H) ☐ Motors ☐ Transformers

☐ Information about Allis-Chalmers motors with Silco-Flex

NAME _____ TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE _____ STATE _____

DOW CORNING SILICONES

DOW CORNING CORPORATION

MIDLAND, MICHIGAN

ATLANTA • CHICAGO • CLEVELAND • DALLAS • DETROIT
LOS ANGELES • NEW YORK • WASHINGTON, D.C. (Silver Spring, Md.)

CANADA: Dow Corning Silicones Ltd., Toronto
GREAT BRITAIN: Midland Silicones Ltd., London
FRANCE: St. Gobain, Paris

*TM REG. U.S. PAT. OFF.

J.B.–
These "Special" features are standard on 1500 and 2500 lb Edward Univalves.
R.Y.P.

ROCKWELL BUILT
Edward Valves

Impactor handle provides tight, effortless closing – No need for cheater.

All forged construction – No porous castings here.

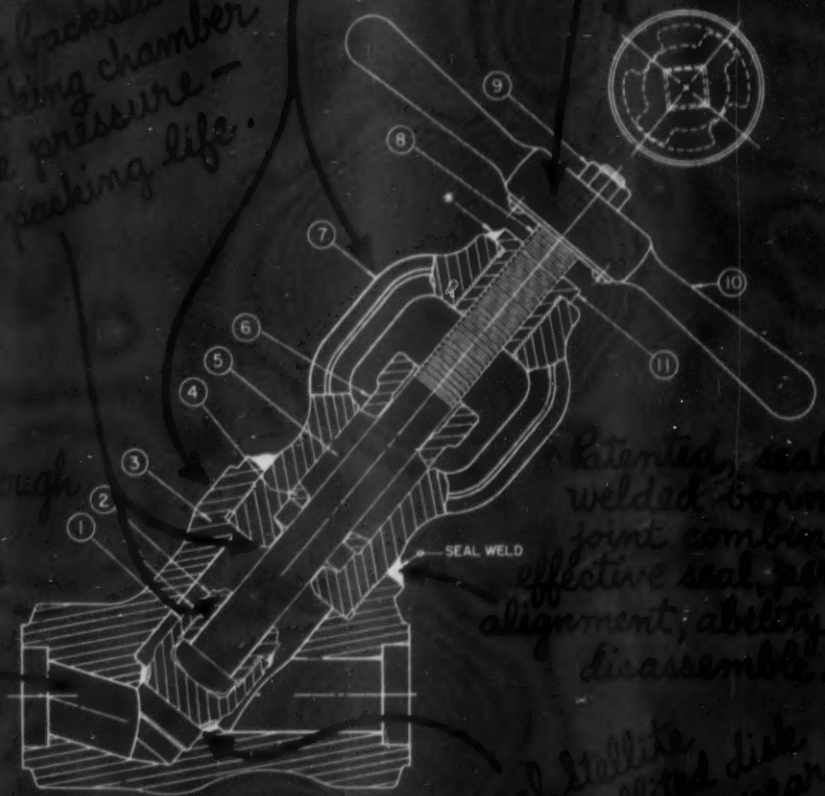
Let's have Edward quote quality and performance are important

Line contact backseat isolates packing chamber from line pressure – prolongs packing life.

Straight-through design minimizes erosive wear due to turbulent flow – extends life.

Patented seal-welded bonnet joint combines effective seal, perfect alignment, ability to disassemble.

Integral Stellite seat – Stellited disk resist wear.



LIST OF MATERIAL
QUANTITIES ARE FOR ONE GLOBE OR ONE ANGLE VALVE
WHERE A.S.T.M. SPECIFICATIONS ARE INDICATED THE LATEST REVISION APPLIES

PIECE NO.	NAME OF PIECE	NO. REQ'D.	MATERIAL	SPECIFICATIONS	EDWARD MS NO.
1	DISK	1	FORGED STEEL	A.S.T.M. A182 GRADE F11	227
2	DISK NUT	1	EVALLOY	A.S.T.M. A182 GRADE F6	212
3	BODY	1	FORGED ALLOY STEEL	A.S.T.M. A182 GRADE F11 (b)	227
				A.S.T.M. A182 GRADE F22 (c)	230
4	JUNK RING	1	STEEL-EVALIZED	A.I.S.I. G1120	123
5	PACKING RINGS		EVALPAK	HIGH TEMPERATURE PACKING	501
6	GLAND	1	FORGED STEEL	A.S.T.M. A105 GRADE II	111
7	BONNET	1	FORGED ALLOY STEEL	A.S.T.M. A182 GRADE F11 (b)	227
				A.S.T.M. A182 GRADE F22 (c)	230
8	STEM	1	EVALLOY	A.I.S.I. GRADE 416	261
9	STEM NUT	1	STEEL	A.S.T.M. A194 GLASS 1 OR 2	124
10	IMPACTOR HANDLE	1	MALLEABLE IRON	A.S.T.M. A47 GRADE 32510	322
11	YOKE BUSHING	1	BRONZE	A.S.T.M. B148 GRADE 9B HT.	432
12	GLAND BOLT NUT	2	STEEL	A.S.T.M. A194 GLASS 1 OR 2	124
13	GLAND STUD	2	STEEL	A.S.T.M. A193 GRADE B7	208
14	GLAND BOLT LOCKNUTS	4	STEEL	A.S.T.M. A194 GLASS 1 OR 2	124

EDWARD VALVES, INC.
SUBSIDIARY OF ROCKWELL MANUFACTURING CO.
EAST CHICAGO, INDIANA

FORGED STEEL UNIVALVES
GENERAL ASSEMBLY
FIG.-3924 SIZES ½, ¾, 1, 1¼, 1½, 2

DRAWN: A. Dubois
CHK'D: J. Piet
APP'D: V. Strutmeyer DATE: 10-1-
DRAWING NO. AE-3593-1

Edward builds Globe and Angle Stop, Non-Return, Check, Stop-Check, Gate, Blow-Off, Mudline, Relief, Hydraulic, Instrument, Gage, and Special Valves and Strainers.

Here Is Extra Motor Value

Double-shielded bearing
Large grease reservoirs
Bolted-on bearing cap
Labyrinth seals

This Allis-Chalmers Bearing Design Gives More for Your Motor Dollar

The bearing cap is held tightly in place against the inner face of the bearing enclosure. This cap, with its close running clearances, keeps grease from the interior of the motor . . . retains an ample supply within the bearing enclosure.

At the outer side of the bearing, double labyrinth seals keep grease in, also keep dirt out. What's more, large grease reservoirs act as additional dirt traps.

You can lubricate these bearings without dismantling motor. Pipe-tapped holes in the bearing housings at two points provide means for inserting new grease, flushing out old grease and of relieving pressure during re-greasing.

Look for the extra bolts on the end housing . . . the sign of greater value. Ask your Allis-Chalmers representative or Authorized Distributor to show you a cutaway section of this maintenance-cutting design. Or write Allis-Chalmers, Milwaukee 1, Wisconsin, for Bulletin 51B7225.

A-4616

ALLIS-CHALMERS

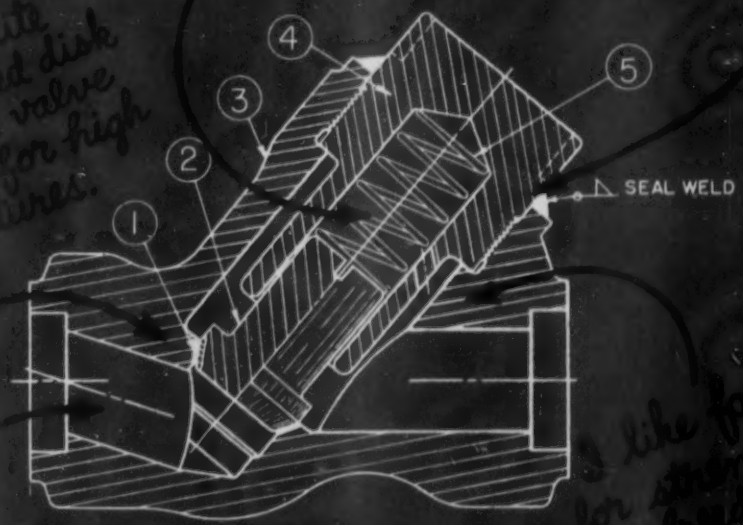
J.B.—
Here is the check valve companion to the Edward Univalve.
R.S.P.

Proven seat-welded joint. Permanently tight yet readily disassembled.

Edward has used this disk-guide-spring design in small checks for many years. Gives excellent alignment and is dependable.

ROCKWELL BUILT
Edward Valves

Integral stellite seat. Stellited disk make this valve suitable for high temperatures.



Straight-through flow is important. Prevents erosion. Keeps seating surfaces clean.

Ask Edward to quote—including these checks.

I like forgings for strength and freedom from porosity. This valve is all forged.

By the way, Edward builds these in 1500 and 2500 pressure classes.

LIST OF MATERIAL
QUANTITIES ARE FOR ONE GLOBE OR ONE ANGLE VALVE
WHERE A.S.T.M. SPECIFICATIONS ARE INDICATED THE LATEST REVISION APPLIES

PIECE NO.	NAME OF PIECE	NO. REQ'D.	MATERIAL	SPECIFICATIONS	EDW. MS NO.
1	SEAT	1	INTEGRAL WITH BODY	STELLITED	483
2	DISK	1	FORGED ALLOY STEEL WITH STELLITED SEATING FACE	A.S.T.M. A182 GRADE F11	227
					481
3	BODY	1	F. ALLOY STEEL	A.S.T.M. A182 GRADE F11 (a)	227
			F. ALLOY STEEL	A.S.T.M. A182 GRADE F22 (b)	230
4	BONNET	1	F. ALLOY STEEL	A.S.T.M. A182 GRADE F11 (a)	227
			F. ALLOY STEEL	A.S.T.M. A182 GRADE F22 (b)	230
5	SPRING	1	STAINLESS STL.	A.S.T.M. TYPE 302	253

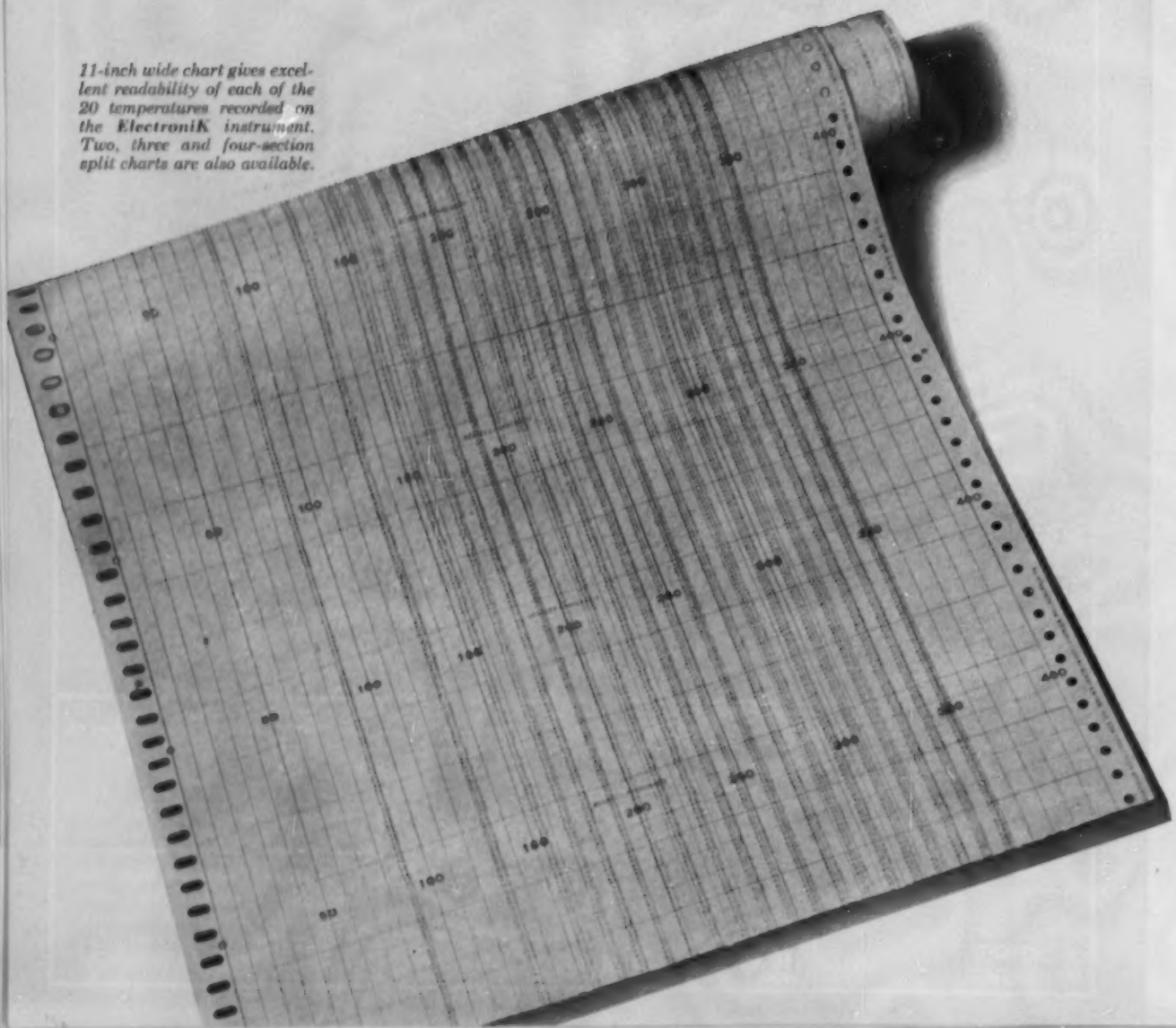
EDWARD VALVES, INC.
SUBSIDIARY OF ROCKWELL MANUFACTURING CO.
EAST CHICAGO, INDIANA

LIFT TYPE CHECK VALVE
GENERAL ASSEMBLY
FIG. 2278 SIZES ½, ¾, 1, 1¼, 1½, 2

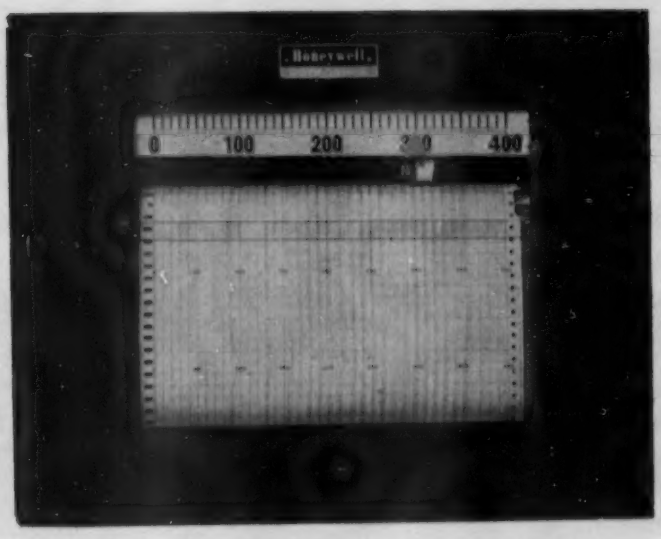
DRAWN [illegible] DRAWING NO.
CHK'D [illegible] BE-3575-2
APP'D [illegible] DATE [illegible]

Edward builds Globe and Angle Stop, Non-Return, Stop-Check, Check, Gate, Blow-Off, Mudline, Relief, Hydraulic, Instrument, Gage, and Special Valves and Strainers.

Detailed records of 20 plant temperatures centralized on a



11-inch wide chart gives excellent readability of each of the 20 temperatures recorded on the ElectroniK instrument. Two, three and four-section split charts are also available.



single *ElectroniK* instrument

One instrument does the work of several . . . saves panel space . . . brings related measurements together for easier, clearer analysis of trends

UP TO 20 different temperatures . . . of water, steam, oil, air, hydrogen, bearings, generator stator or other critical spots . . . can be recorded by this *ElectroniK* instrument. This large capacity reduces your instrumentation investment . . . for one instrument can do the work that used to require two conventional recorders. At the same time, panel space for temperature measurements is cut in half.

When you're choosing temperature instrumentation, specify the 20-point *ElectroniK* recorder, to be sure of obtaining—

The kind of records you want. All 20 records can be printed on a chart with a single range, as illustrated here. To separate curves and avoid overlapping, charts with two, three or four separate split sections can be provided.

The recording speed you need. The instrument can be supplied to record at a rate of 30, 15, 5 or 2 seconds per point. You can choose the frequency of temperature checking that your plant requires.

The dependability you demand. Thousands of *ElectroniK* instruments, in power plants and other industrial service, have earned a world-wide reputation for reliability. Their rugged, simple designs make use of basic components engineered for the utmost in long life and precision. In installation, start-ups and emergencies, service is available promptly from Honeywell's coast-to-coast organization.

Ask your local Honeywell sales engineer to come in for a discussion of your power plant measurement problems. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—In Canada, Toronto 17, Ontario.

● **REFERENCE DATA: Write for Specification Sheet No. 165-1, "*ElectroniK* Strip Chart Recorders." Bulletin No. 9050R, "Instruments for Steam Generation."**

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

Research-Cottrell makes both

The choice of a straight precipitator or a combination mechanical-electrical precipitator for fly ash recovery depends on many factors—size and composition of the fly ash, efficiency desired, space available for the equipment, initial cost, etc.

Whatever your fly ash problem you can be sure of unbiased recommendations from Research-Cottrell, because we offer both types—and have done so for many years.

The cutaway drawings on the next page show several design features of both the straight Cottrell precipitator and the combination mechanical-electrical precipitator offered by Research-Cottrell.

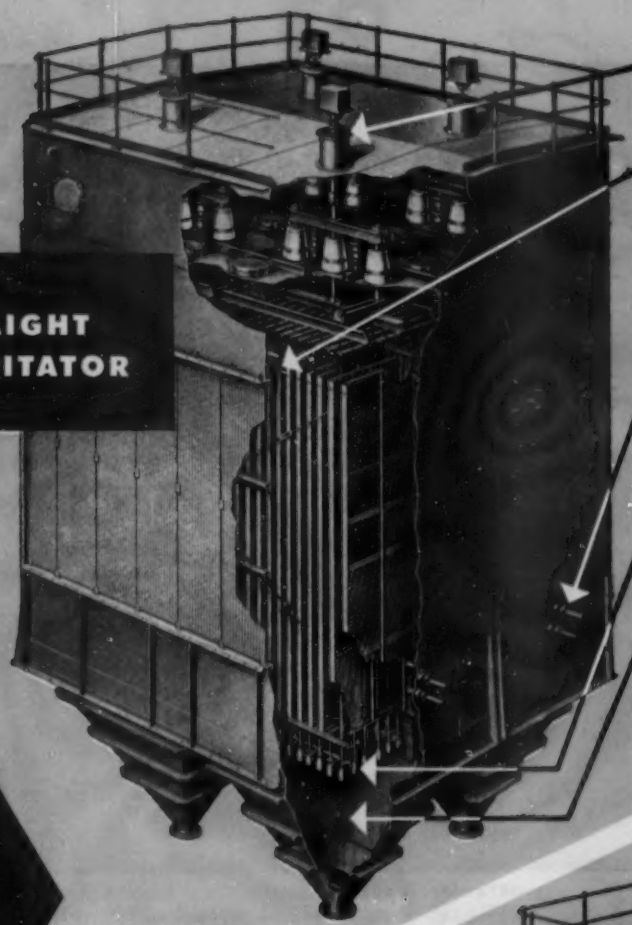
These basic designs, as well as Research-Cottrell's custom engineering of each installation, are backed by over 40 years experience and over 500 fly ash collectors. For more details on this equipment write for Bulletins GB and FA.

Precipitator is designed and constructed for many years of heavy-duty, all-weather service.

RESEARCH-COTTRELL, INC.

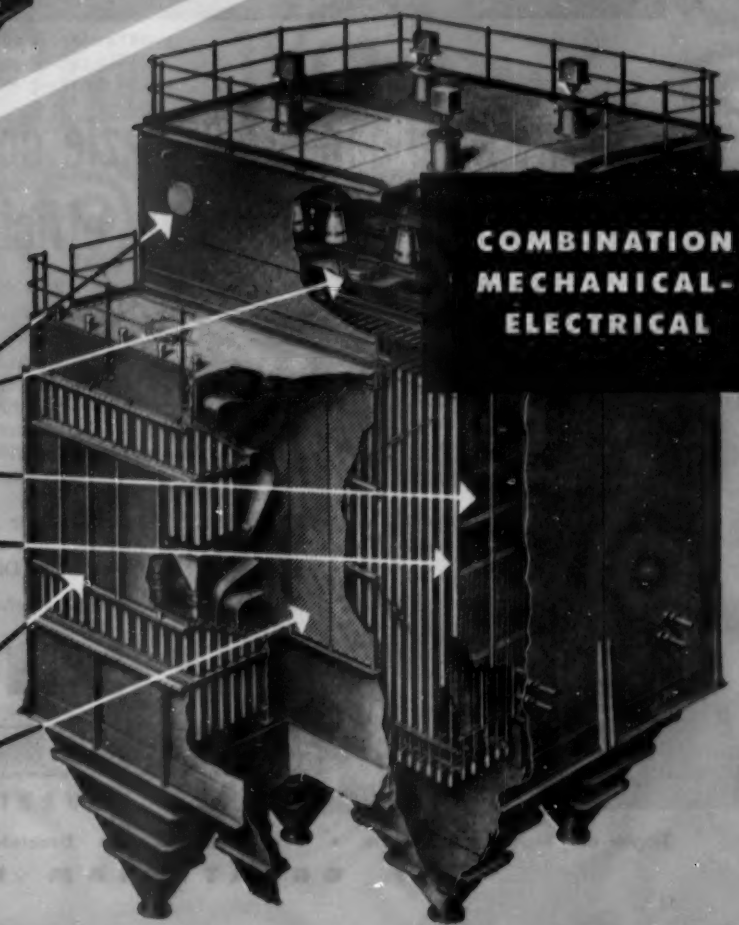
A Wholly Owned Subsidiary of Research Corporation

Main Office and Plant: Bound Brook, N. J. • 405 Lexington Ave., New York 17, N. Y. • Grant Building, Pittsburgh 19, Pa. • 228 N. La Salle St., Chicago 1, Ill. • 111 Sutter Bldg., San Francisco 4, Cal.



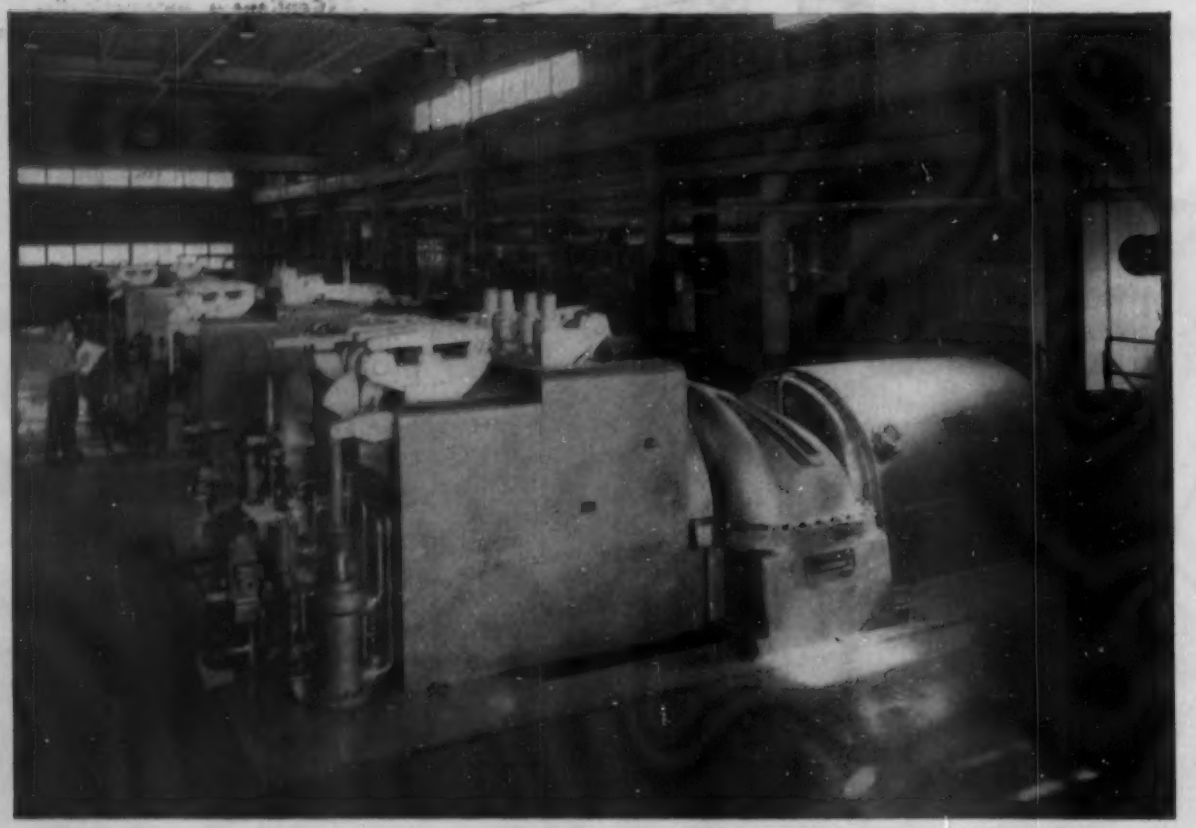
STRAIGHT PRECIPITATOR

1. Continuous, automatic discharge electrode rapping insures optimum performance.
2. Hook-type collecting electrode hangers, quickly installed, insure uniform distribution of rapper vibration throughout entire collecting surface.
3. Rapping puffs prevented by automatic and continuous cleaning of collecting electrodes with Magnetic Impulse Rapper (patents pending).
4. Plumb-bob discharge electrodes are individually weighted and positioned by a steadying frame for maximum efficiency.
5. Hopper baffle prevents gas sneakage around electrodes.



COMBINATION MECHANICAL-ELECTRICAL

6. Easy access to high tension equipment.
7. No moving parts in gas stream—minimizes maintenance.
8. End and intermediate baffles provide quiescent zones and prevent re-entrainment of collected dust.
9. Compact double-deck mechanical collector (patented) provides large capacity in a small area.
10. Double-deck mechanical collector design insures even gas distribution at precipitator inlet.



WORTHINGTON TURBINE-GENERATORS, Anchorage, Alaska. These 3000-kw turbine-generators give economical, trouble-free service in one of the few plants in this vicinity.

Why cam-operated nozzle control valves* pay off in turbine-generator efficiency, lower costs

Here are five reasons *all* Worthington multivalve turbine-generators — down to the smallest — are equipped with cam-operated valves for precision nozzle flow control:

1. Individual cams are shaped to give best flow-lift characteristics, resulting in close frequency or speed control.
2. Valves open in sequence, correct overlap being easy to obtain by adjustment, assuring smooth power response.
3. Valve operation can be checked without breaking any steam joint, since mechanism is outside steam chest.
4. Valve operation can be readily adjusted after installation to suit load conditions.
5. No operating oil above the steam chest, eliminating fire hazard.

Another reason for top performance with every Worthington steam turbine-generator is the fact that turbine and generator are designed as a unit. Before shipment both the turbine and the generator are put together in the Worthington factory and tested as *one unit.*

For more facts about Worthington turbine-generators, write to Worthington Corporation, Steam Turbine Division, Section T.5.5, Wellsville, N.Y. T.5.5

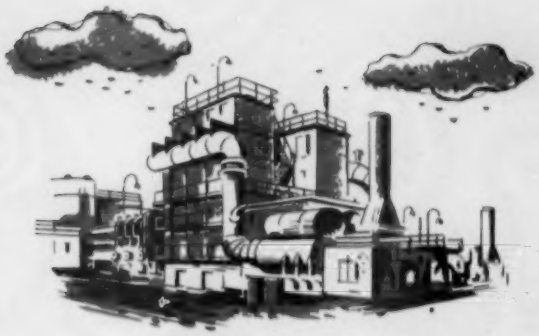
**Standard on all Worthington multivalve turbine-generators*

WORTHINGTON

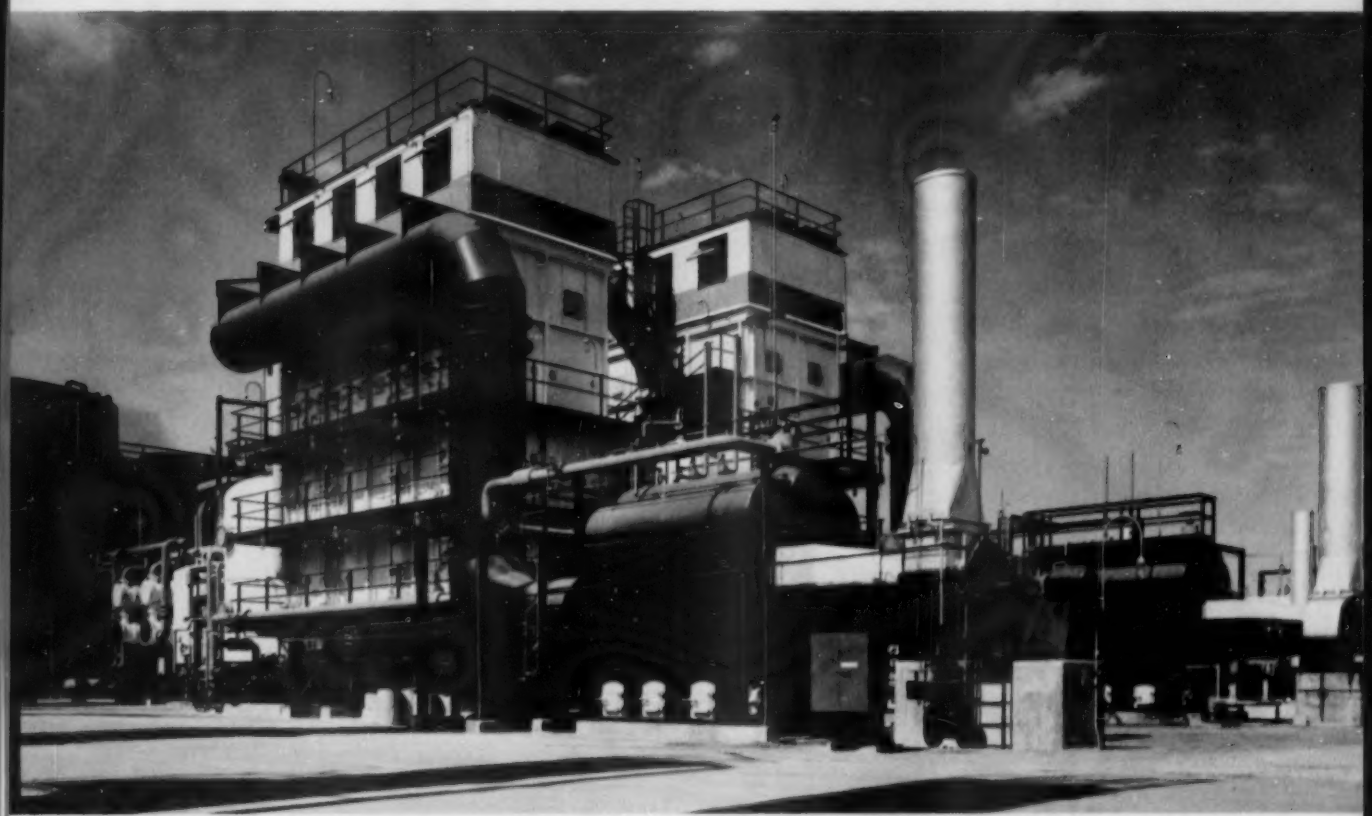
STEAM TURBINES

Single- and Multi-Stage Turbines • Turbine-Generators • Deaerators • Boiler Feed Pumps • Surface Condensers

A GREAT TEAM IN STEAM



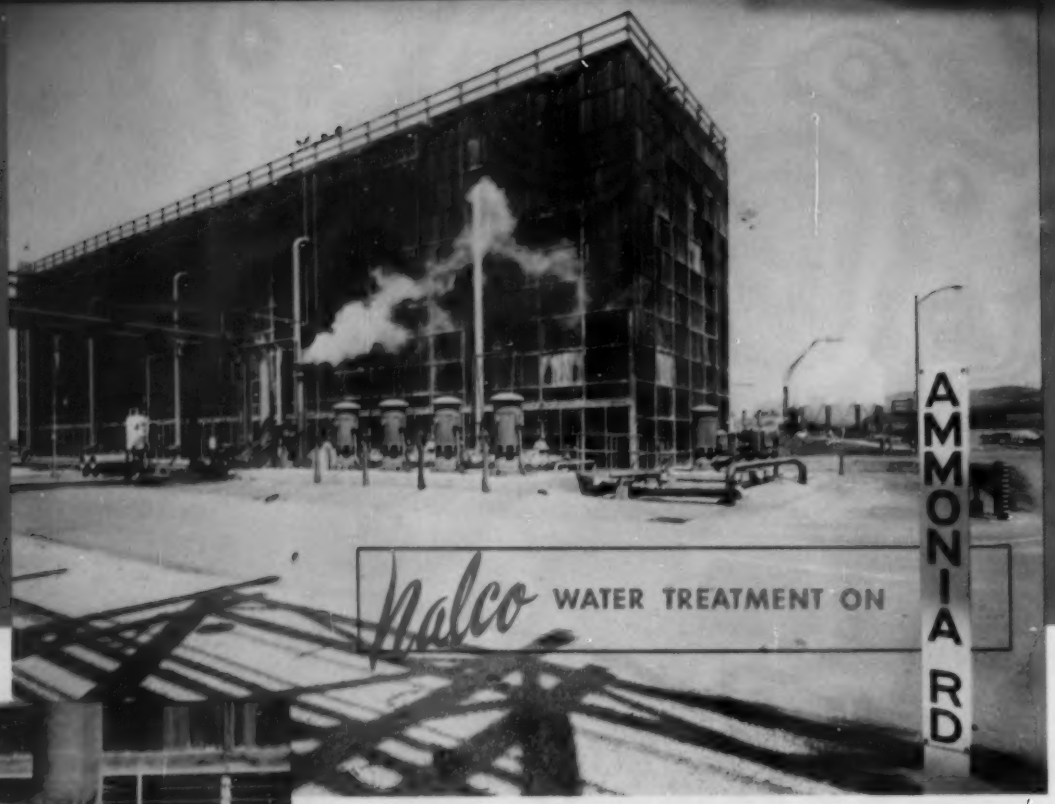
Water treatment by NALCO protects boilers and cooling system of a big new ammonia plant

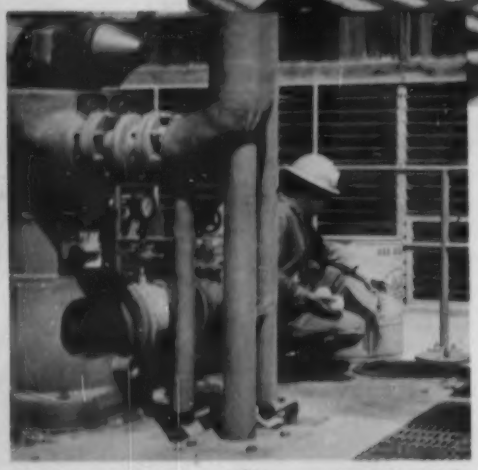


Processing units (left) and Nalco-protected waste heat boilers in new $13 million Brea Chemicals, Inc. ammonia plant.

When $13,000,000 goes into a brand new ammonia plant . . . equipment, services and supplies must be right up to snuff from the start. The Nalco System has been working here from the beginning—and the Nalco treatments and services rendered in a successful plant-wide program point up the advantages to be gained with the Nalco System in plants new or old.

See the next page for details on Nalco results on Ammonia Road.



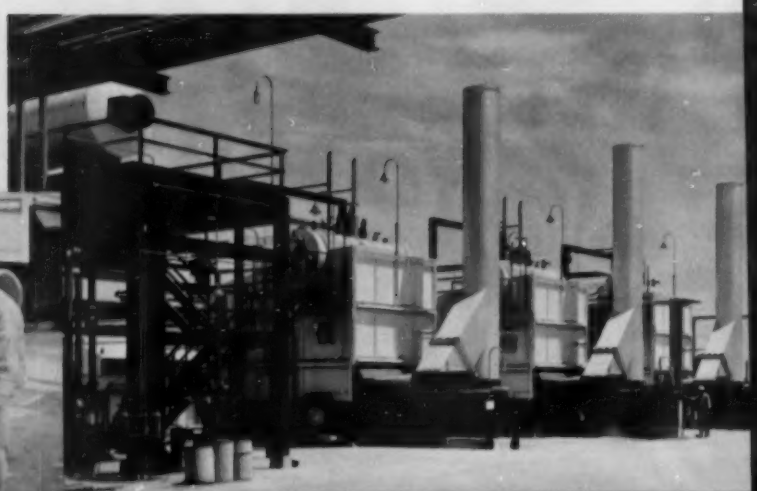


Nalco System treatments on Ammonia Road solve these important water and steam processing problems: scale and corrosion prevention in both water and steam systems; boiler-water foam control and sludge-conditioning; and contamination-free process steam.

Whatever your water treatment problems may be—in a plant of any size—there is a Nalco System program designed to solve them, permanently . . . and economically. Write or phone today for details.

Top—Large cooling tower at this new west coast ammonia plant gets protection against scaling and corrosion with a non-toxic Nalco formula. Low pH treatment stops deterioration of cooling tower lumber and cuts dosage requirements for slime and algae control.

Above—Ball form cooling water treatment is merely dropped into a simple wire basket device suspended in cooling tower basin.



Above—These steam generators on outdoor settings provide superheat steam for ammonia processing and heating. Nalco chemicals in ball-briquet form are put into by-pass feeders *(left)* to insure trouble-free water treatment on Ammonia Road.

NATIONAL ALUMINATE CORPORATION
Phone: POrtsmouth 7-7340
6216 West 66th Place
Chicago 38, Illinois

In Canada, Alchem Limited
Burlington, Ontario

THE nalco® SYSTEM . . . Serving Industry through Practical Applied Science

J. M. CRAWFORD, VICE PRESIDENT AND GENERAL MANAGER OF MOTOR & GENERATOR DIVISION, AND A. H. LAUDER, MANAGER OF LARGE MOTOR & GENERATOR ENGINEERING, INSPECT NEW G-E DEVELOPMENT LAB.

In new G-E development laboratory giant motors perform just as in service

One of the most difficult problems design engineers face is predicting accurately how a large motor will perform under actual operating conditions. G.E. has come up with an answer to this problem.

INCREDIBLY ACCURATE TEST CONDITIONS are made possible by the brand new G-E test laboratory pictured above. A huge synchronous generator with a base rating of 60,000-kva, driven by a variable speed d-c motor, provides current of variable frequency to the equipment on test.

Large a-c and d-c motors and generators, synchronous condensers, and giant hydro-generators can now be fully tested under conditions more severe than are encountered in the field. You are thus assured your G-E equipment will give you the maximum of long life and efficient operation.

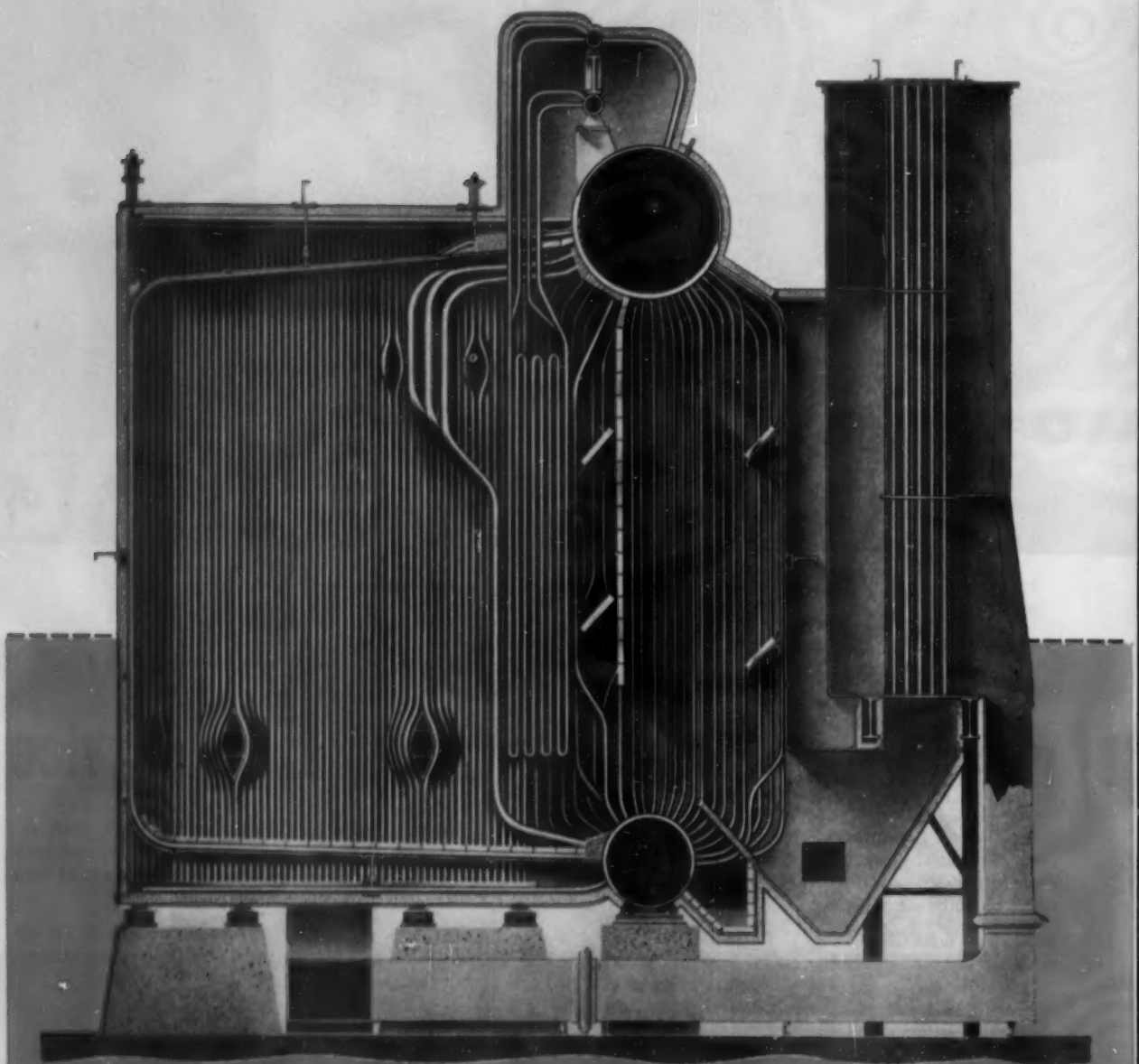
UNDER THIS TEST LAB REALISM, data will be obtained which can be translated by G-E engineers into further design improvements.

Take advantage of this progressive research and bring your large motor and generator problems to General Electric. For more complete information call the nearest G-E Apparatus Sales Office. General Electric Co., Schenectady 5, N. Y. 770-18

Progress Is Our Most Important Product

GENERAL ELECTRIC

These performance-proved features



SPECIFICATIONS

Sizes—Five sizes ranging from 50,000 to 120,000 lb of steam per hr.

Pressures—250 to 860 psi (all sizes)

Temperatures—as required up to 750 F

Fuels—oil or gas, pressure fired

Heat Recovery—Tubular or Regenerative Air Preheater

make Combustion's NEW VU-55

today's outstanding boiler buy for capacities from 50,000 to 120,000 lb of steam per hour!

The VU-55—a development of Combustion's basic *V*ertical *U*nit design—offers features never before available in a boiler of its capacity range. If your steam needs call for a unit in the 50,000 to 120,000-lb class, you will find it worth while to consider the economic and operating advantages assured by these VU-55 features:

TANGENTIAL FIRING. More than 20 years of application experience have established the exceptional advantages of tangential firing, illustrated and briefly described below. About 90 percent of Combustion's large utility installations use this advanced method of firing.

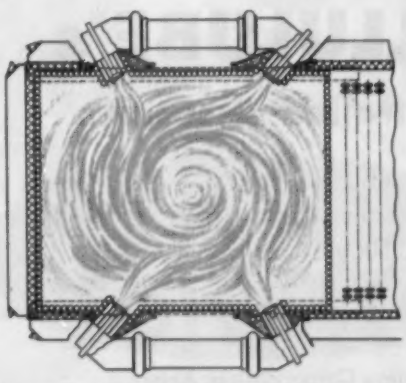
DOUBLE WALL, PRESSURIZED CASING. The latest development in casing construction for pressure firing of boilers in the size class of the VU-55, this casing, as illustrated and described below, is designed to assure life-time tightness with minimum heat loss. Pressure firing permits the elimination of an induced draft fan with its attendant operating and maintenance costs.

TANGENT FURNACE TUBES. The VU-55's furnace tube arrangement provides complete heat-absorbing, water-cooled protection on all furnace walls. Furnace maintenance is minimized, refractory expense is eliminated, heat absorption rates per sq ft are higher.

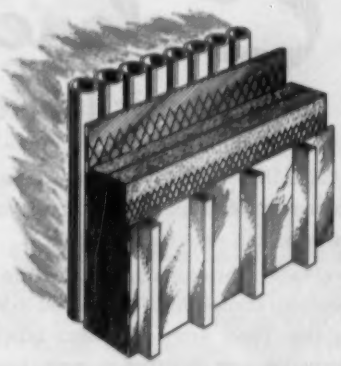
HIGH STEAM QUALITY. Equipped with a large (60-in.) steam drum, the VU-55 has generous water capacity and steam reservoir space. C-E drum internals assure high quality steam at all ratings.

STREAMLINED EXTERIOR. The over-all appearance of the VU-55 reflects the efforts of its designers to achieve a completely unobstructed casing, while retaining adequate access wherever required and every facility for convenient operation. There are no outside downcomer tubes, and ducts from air heater to burners are beneath the furnace floor.

Your request for further information on the VU-55 Boiler will receive prompt attention.



PLAN VIEW OF FURNACE showing arrangement of burners for tangential firing. Flame streams from the four burners impinge upon one another at high velocity, creating a turbulence unattainable by any other method of firing. The result is rapid and complete combustion. As the gases spiral upward, they sweep all furnace heating surfaces, assuring a high rate of heat absorption.



PERSPECTIVE OF FURNACE WALL. Construction consists of tangent tubes backed up successively by welded steel panels, 4 inches of high quality insulating material and an outer steel casing formed as shown to provide adequately for expansion and assure ample strength. Low heat loss and the tightness required for pressure firing are assured by this welded, double-wall construction.

COMBUSTION ENGINEERING

Combustion Engineering Building, 200 Madison Avenue, New York 16, N. Y.
CANADA: COMBUSTION ENGINEERING-SUPERHEATER LTD.

B-870

STEAM GENERATING UNITS; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; DOMESTIC WATER HEATERS; SOIL PIPE

Battery of 1100 H.P. Worthington Compressors at Celanese petrochemical plant, Bishop, Texas, where CELLULUBE* 220 has given efficient service since 1952.

Celanese* CELLULUBE*s

synthetic lubricants in controlled viscosities

Celanese CELLULUBES have been developed to meet the pressing need for non-carbon-forming lubricants that are both safe and efficient.

These synthetic lubricants are phosphate esters—straight chemical compounds controlled to specification viscosities. They have excellent lubricity . . . are non-corrosive, non-reactive, non-oxidizing in air compressor service.

CELLULUBES are non-petroleum oils. They greatly reduce the formation of carbon deposits, a prime source of air compressor explosions and fires.

CELLULUBES have been job-tested for 3 years in actual compressor installations. Evaluate them in your own operation. Use coupon below to order samples and complete technical data.

Celanese Corporation of America
Chemical Division, Dept. 597-J
180 Madison Avenue, New York 16, New York.

Celanese Corporation of America, Chemical Division, Dept. 597-J
180 Madison Avenue, New York 16, N. Y.

Please send me sample and technical bulletin on Cellulube fire-resistant Synthetic Lubricants for air compressor service.

NAME _____

TITLE _____

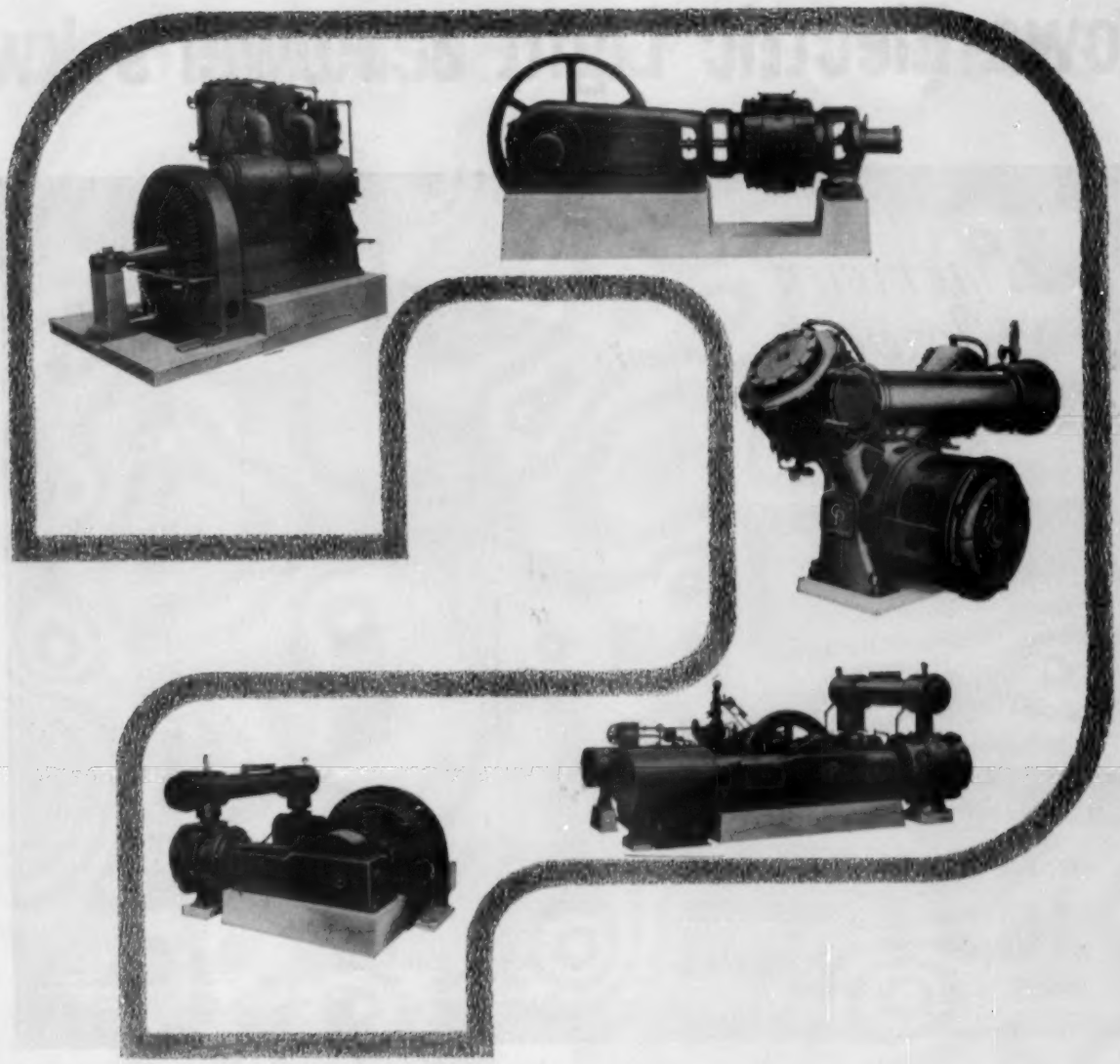
COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

Celanese* CHEMICALS

*Reg. U.S. Pat. Off.



WHAT DO YOU WANT IN A COMPRESSOR?

Whatever your requirements, there's a CP Compressor to fulfill your air needs at minimum operating and maintenance costs. Whether the type is portable or stationary . . . single-stage or multi-stage . . . lubricated or oil-less cylinder . . . vertical or horizontal . . . air-cooled or water-cooled . . . for air or gas compression, you can select from Chicago Pneumatic's wide line of compressors. Capacities range from 60 to 10,000 cfm., 7½ to 2000 hp. For complete information on the type compressor you have in mind, write *Chicago Pneumatic Tool Company, 8 East 44th Street, New York 17, N. Y.*

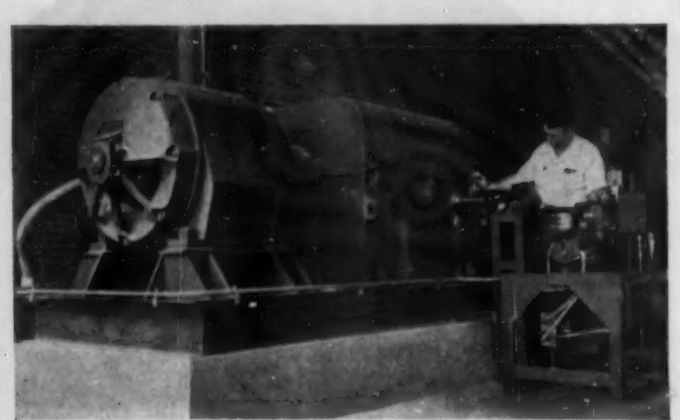
Chicago Pneumatic

PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS • AVIATION ACCESSORIES

Iowa Electric Light & Power's kw

Iowa Electric's new Sutherland Station, under construction at Marshalltown, will have two generating units. First unit, with 33,000 kw capacity, was completed in 1955.

American Blower Induced Draft Fans on Sutherland Station's new No. 1 unit are rated @ 97,000 cfm @ 356° F @ 11.75" sp @ 239.0 bhp.



Driving induced draft fan, American Blower Gyrol Fluid Drive – class IV, type VS – provides adjustable speed control; is rated @ 250 hp @ 870 rpm.

sales increase 356% in 17 years!

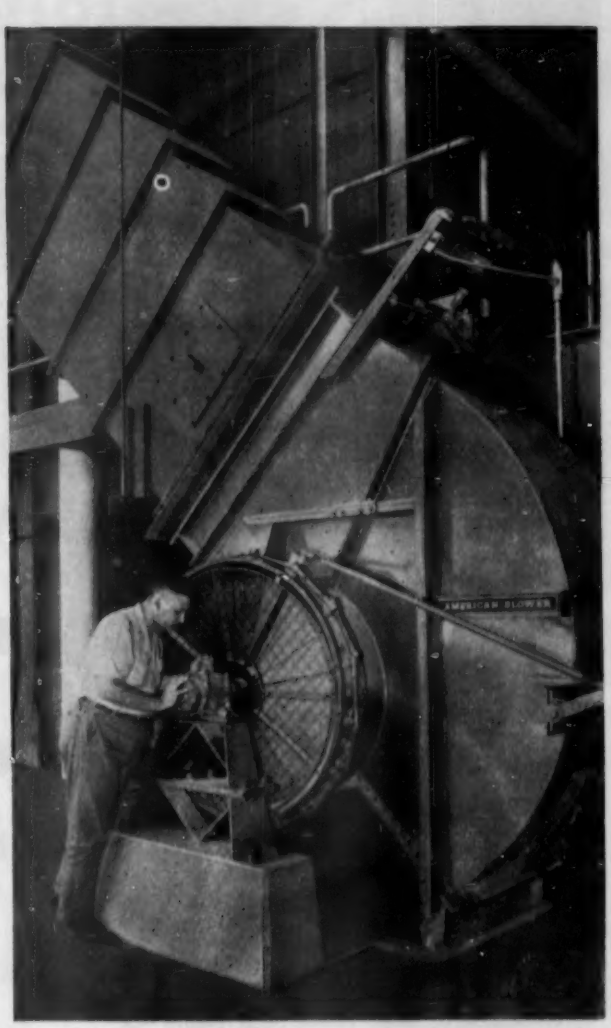
Relying on experience, rapidly expanding utility chooses American Blower air-handling equipment

1936 ushered in a phenomenal growth period for the Iowa Electric Light and Power Company. Fast-rising electrical needs called for new and larger facilities, longer distribution lines. Two mergers extended the company's operations. By 1953, 17 years later, Iowa Electric was serving 51 counties — and kilowatt-hour sales were up 356%! Today, Iowa Electric's facilities are still mushrooming. And the end is nowhere in sight!

Expansion has included new electrical generating units at the Boone and Cedar Rapids Plants . . . where American Blower Forced and Induced Draft Fans, Gyrol Fluid Drives, and a Fly Ash Precipitator were installed. This equipment has proved so dependable and free of maintenance that Iowa Electric again chose American Blower for Sutherland Station, its new plant at Marshalltown, completed in 1955 (first of two units to be constructed).

Experience has led many other progressive, investor-owned utilities to specify American Blower again and again, when expanding or modernizing. "There's no substitute," they report, "for the quality of American Blower Mechanical Draft Fans, Fly Ash Precipitators, Heavy-Duty Steam Coils, and Gyrol Fluid Drives for boiler feed pump and fan control." They rely on American Blower . . . you can too.

American Blower branch offices are conveniently located throughout the U.S. You'll find one of our representatives easy to contact — to discuss *your* problems.



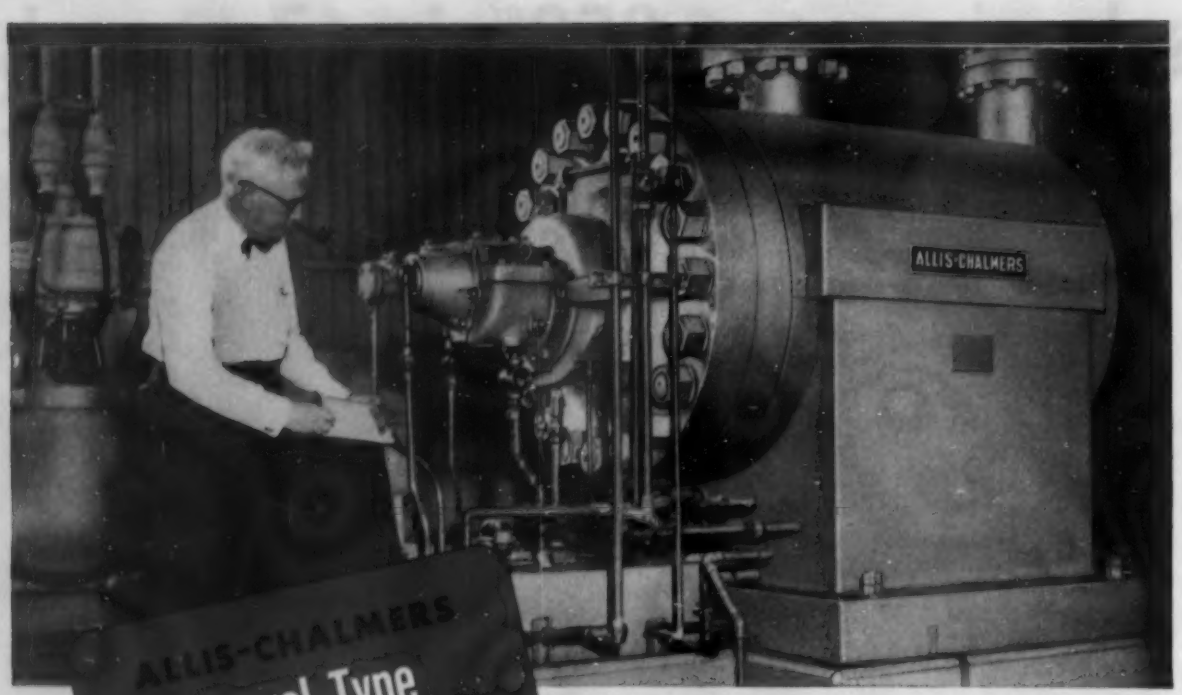
No. 1 unit at Sutherland Station uses American Blower Forced Draft Fans, each with 57,500 cfm capacity @ 120° F @ 11.6" sp @ 138.0 bhp.

AMERICAN BLOWER CORPORATION
DETROIT 32, MICHIGAN

CANADIAN SIROCCO COMPANY, LTD.
WINDSOR, ONTARIO

Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER



ALLIS-CHALMERS
Barrel-Type
BOILER FEED PUMPS

In the Dallas Steam Electric Station

OF THE DALLAS POWER & LIGHT COMPANY

What Are Your Pump Needs?

Whether you require boiler feed, condensate, circulating or other power plant pumps — a careful study will reveal why more and more utilities are specifying Allis-Chalmers. Check the design features, the operating advantages, the provisions that make a pump easier to maintain, or service. You, too, will find it pays to standardize on Allis-Chalmers Power Plant Pumps.

Complete Unit from One Source

Allis-Chalmers can supply the complete pumping unit—pump, motor and control—of coordinated design and manufacture. You get one responsibility—one guarantee of satisfaction.

Get complete information on Allis-Chalmers barrel-type boiler feed pumps. Call your Allis-Chalmers District Office or write Allis-Chalmers, Milwaukee 1, Wisconsin, for Bulletin 08B7899.

Here Are Important Features that Keep Operating Costs Low:

- First stage has twin, single-suction impellers to give low NPSH requirement for highest efficiency under fluctuating loads.
- Impellers, mounted back to back, balance axial forces without use of balancing drum.
- Double volute casing maintains radial balance under fluctuating load.
- Expansion joint and shaft seals are brought to outside of pump where they may be inspected often and worked on easily, if required.

A-4790

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

THEY WANTED A SINGLE RESPONSIBILITY CONTRACT

The National Petro-Chemicals Corporation wanted a single responsibility contract for the construction of their plant at Tuscola, Illinois.

THEY CHOSE PRITCHARD

The master contract offered by Pritchard assumes full responsibility for engineering, design, drafting and construction. You benefit four ways: 1. You know the total cost before the job begins. 2. You have a firm guarantee of operation and efficiency of the completed plant. 3. You realize great savings from co-ordinated purchase of materials . . . reduction of labor costs . . . uniform control of construction. 4. You realize a faster return on your investment because of earlier completion date.

INDUSTRY'S PARTNER FOR PROGRESS

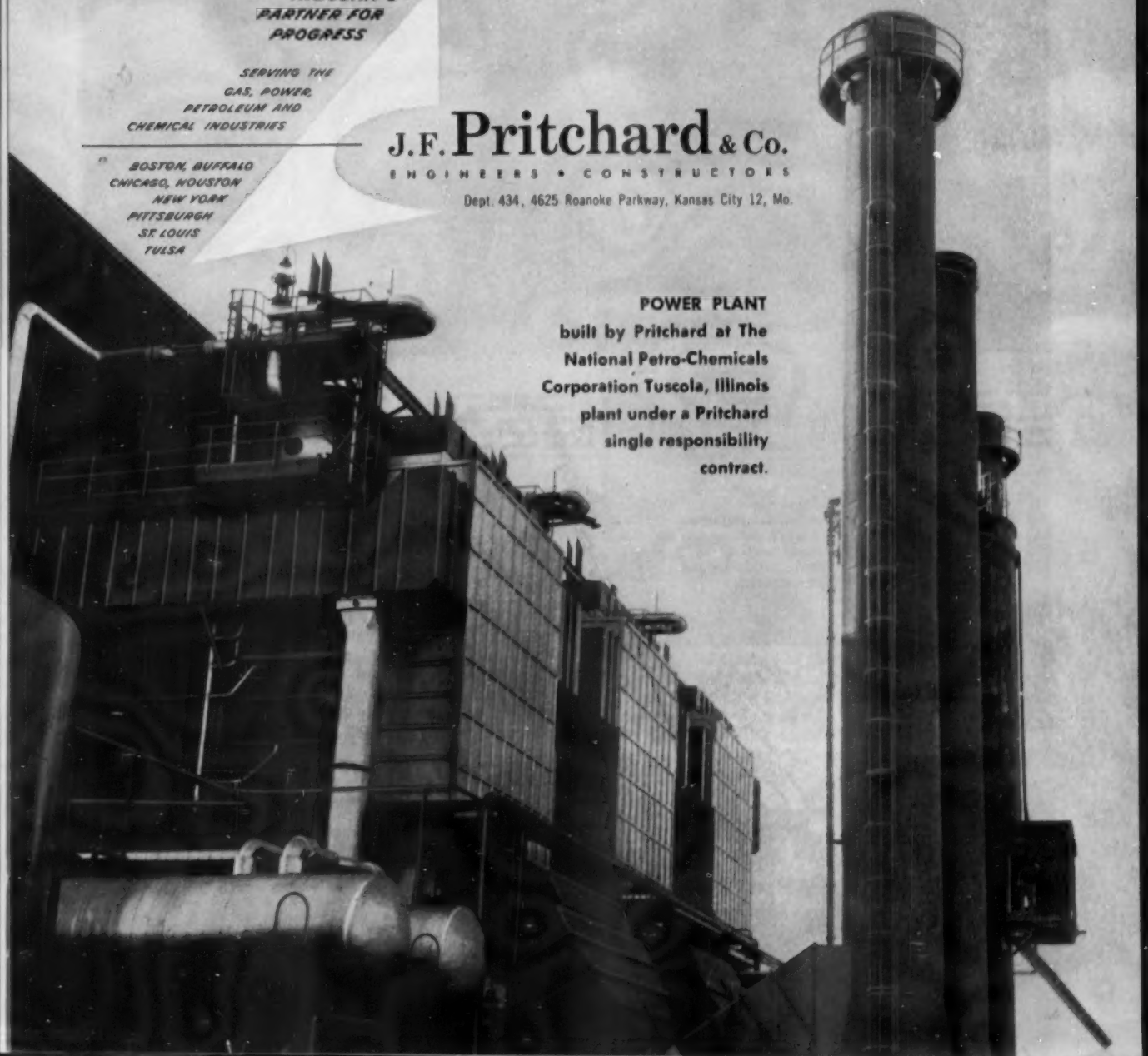
SERVING THE GAS, POWER, PETROLEUM AND CHEMICAL INDUSTRIES

BOSTON, BUFFALO CHICAGO, HOUSTON NEW YORK PITTSBURGH ST. LOUIS TULSA

J.F. Pritchard & Co.

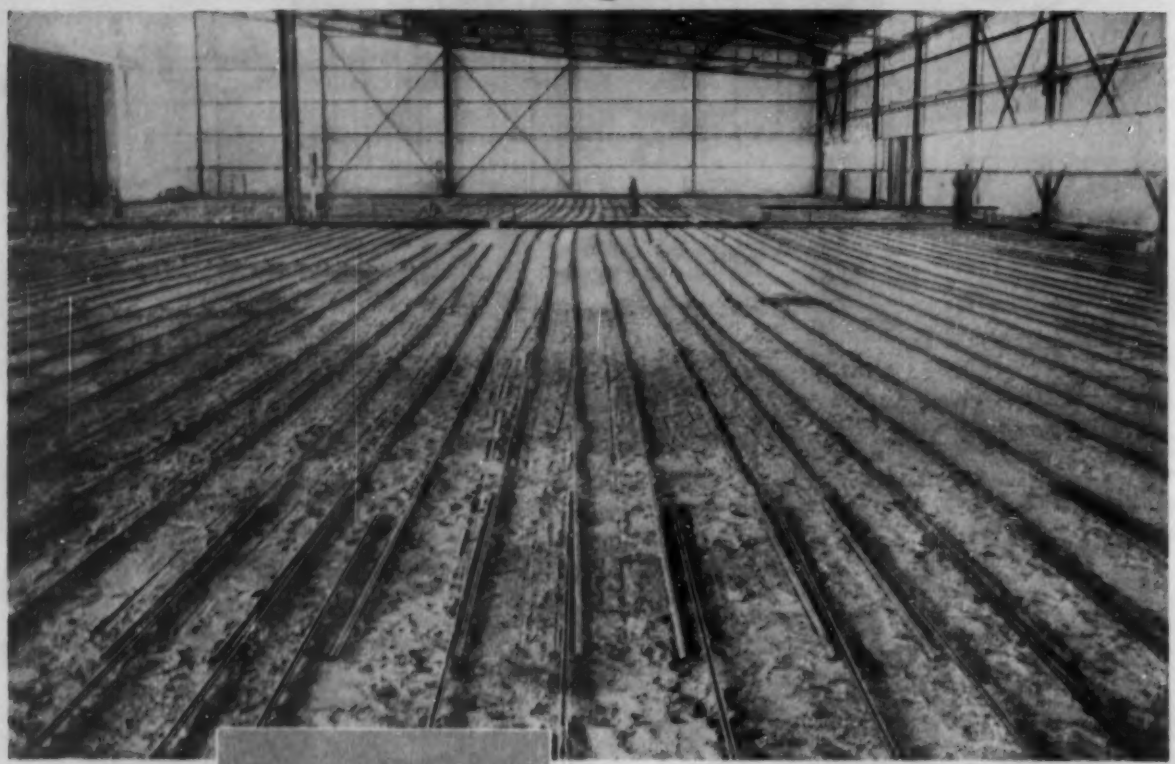
ENGINEERS • CONSTRUCTORS

Dept. 434, 4625 Roanoke Parkway, Kansas City 12, Mo.



POWER PLANT built by Pritchard at The National Petro-Chemicals Corporation Tuscola, Illinois plant under a Pritchard single responsibility contract.

YOUNGSTOWN specified for radiant heating at O'Hare field



Airplane Hangar, O'Hare Field, Chicago, Illinois. Lundstrom & Schubie, Chicago, architects. George J. Ramos Construction Co., Chicago, general contractor. Reliable Heating Co., Park Ridge, heating contractor. Bell & Gossett Co., Morton Grove, heating material.

7 reasons why YOUNGSTOWN PIPE was selected

1. Uniform Ductility
2. Uniform Lengths
3. Uniform Threading
4. Uniform Weldability
5. Uniform Wall Thickness and Size
6. Uniform Strength and Toughness
7. Uniform Roundness and Straightness

Modern radiant heating will be keeping this 52,000 sq. ft. hanger snug when winter winds sweep O'Hare Field in Chicago. Snow, blown in when hanger doors are open, will melt immediately instead of creating a hazardous condition.

Projects such as this are typical of our jet age. And, the fact that Youngstown Pipe was chosen for this heating job is another evidence of its recognized dependability. Made only of the finest steel—its quality closely controlled by one producer from ore mine right through to the final threading operation—the Youngstown Pipe buried in the concrete floor will provide adequate heating service for years to come.

Next time you order pipe, be sure you get YOUNGSTOWN.

HAVING PROBLEMS?

For information and service, get in touch with the local distributor of Youngstown Steel Pipe—or phone our nearest District Sales Office.

Youngstown

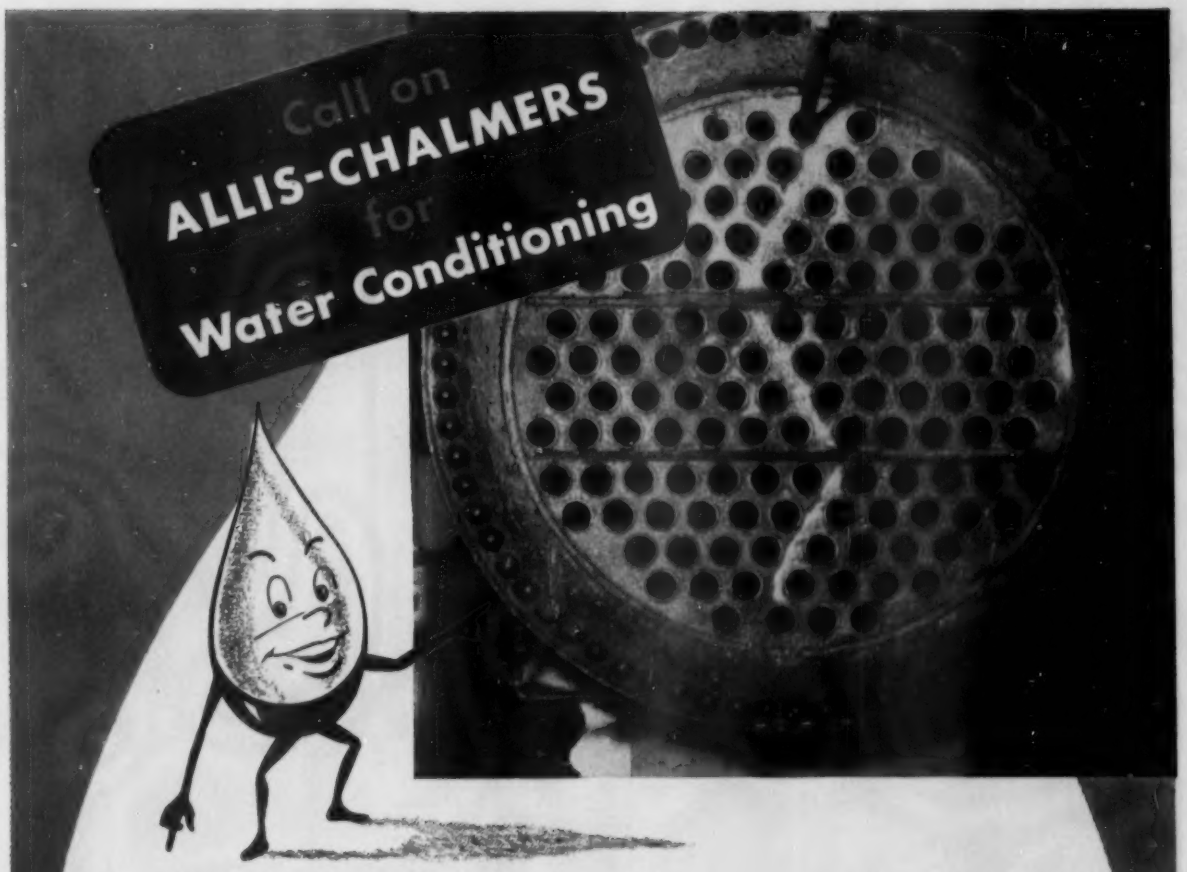
QUALITY YOUNGSTOWN SERVICE

THE YOUNGSTOWN SHEET AND TUBE COMPANY

Manufacturers of Carbon, Alloy and Yoloy Steel

General Offices Youngstown, Ohio District Sales Offices in Principal Cities

SHEETS - STRIP - PLATES - STANDARD PIPE - LINE PIPE - OIL COUNTRY TUBULAR GOODS - CONDUIT AND EMT - MECHANICAL TUBING - COLD FINISHED BARS - HOT ROLLED BARS - WIRE - HOT ROLLED RODS - COKE TIN PLATE - ELECTROLYTIC TIN PLATE - BLACK PLATE - RAILROAD TRACK SPIKES - MINE ROOF BOLTS



12 MONTHS OF CONDENSER OPERATION AND . . .

Absolutely No Scale or Corrosion

Always before, every year, a heavy maintenance job. Until this year, that was the story of the horizontal ammonia condensers at the 4th Street Plant of Terminal Refrigerating and Warehousing Corp., Washington, D. C. Now Allis-Chalmers chemical treatment has provided a new picture, shown above.

You can see for yourself — there are no signs of scale or corrosion. There are scars from cleanings after previous years' operation because it used to be routine to find fairly heavy deposits partially plugging most of the tubes.

After complete analysis of both incoming water and operating conditions, Allis-Chalmers water conditioning engineers provided a recommendation that resulted in a vastly reduced maintenance problem for the plant engineer. A-C engineers also advised on efficient means for introducing the necessary chemicals into the system.

For your own water problems, it will pay to take advantage of Allis-Chalmers experience. Get more information — or a specific consultation on your problems — by calling your nearby A-C office. Or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

A-4823

ALLIS-CHALMERS

WATER CONDITIONING—CHEMICALS, EQUIPMENT, SERVICE—FOR OVER 25 YEARS

A-C ALLIS-CHALMERS

At this large southern power station, exhaust steam lines from turbines to stage heaters are insulated by a combination of K&M "Featherweight" 85% Magnesia and K&M Hy-Temp Insulations.

K&M HIGH PRESSURE INSULATIONS
save heat, cut costs

In plants of almost every type, the heat-saving efficiency of K&M High Pressure Insulations keeps steam losses down, shrinks operating costs. There's a complete K&M line to satisfy all heat insulation requirements—efficiently, economically.

For efficiency to 1900°F.—K&M Hy-Temp Insulation. It's made of diatomaceous silica combined with heat-resistant fillers and asbestos fiber. Usually applied together with K&M "Featherweight" 85% Magnesia.

For efficiency to 600°F.—K&M "Featherweight"® 85% Magnesia. Notably efficient in insulating piping and equipment at temperatures to 600°F. Composed of 85% basic carbonate of magnesia and asbestos fiber, K&M "Featherweight" withstands moisture, vibration, and frequent temperature changes.

Hy-Temp and "Featherweight" combined, and applied so that joints are staggered, eliminate the heat loss that normally occurs in single-layer installations—particularly when piping expansion causes insulation joints to open.

Where severe water exposure is a problem—K & M "Featherweight" Water-Resistant Magnesia is especially effective. Also recommended for applications where high humidity and moisture are present. It withstands temperatures to 450°F.

K&M High Pressure Insulations are sold through distributors who are experienced applicators. Contact your K&M distributor, or write directly to us, for further information.

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

K&M best in asbestos®

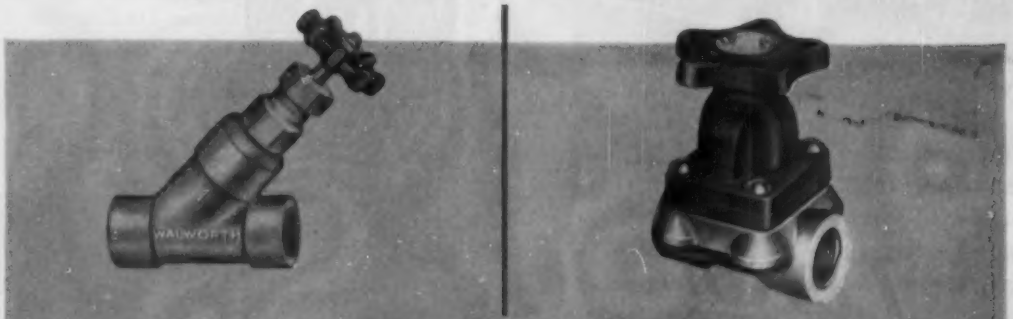
In Canada: Atlas Asbestos Company, Limited; Montreal, Toronto, Winnipeg and Vancouver

Iron... Steel... Bronze...

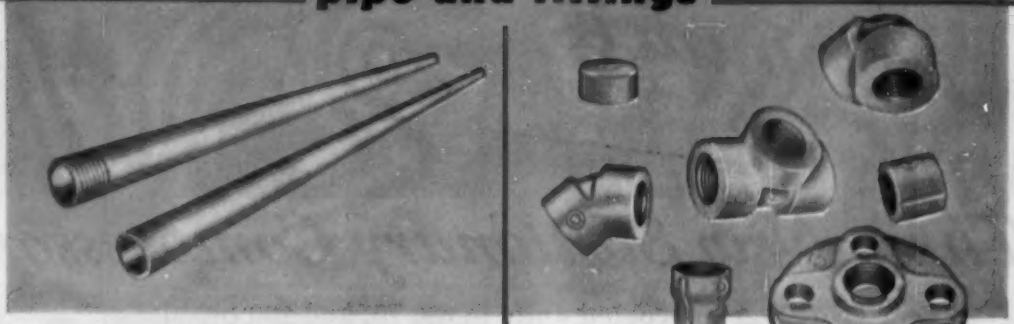
Special Alloys **and now...** *PLASTICS!*

WALWORTH PVC

globe and diaphragm valves



pipe and fittings



CORROSION-RESISTANT TO GIVE YOU NEW AND LASTING PROTECTION!

Walworth rigid plastic polyvinyl chloride valves, *and* fittings provide safe, trouble-free lines to handle wet and dry hydrogen gas—sulphur dioxide—dilute nitric acid—sulphuric acid—natural gas—sugar juice—milk—vinegar—tanning solutions and literally scores of other corrosive as well as noncorrosive materials in the chemical, petroleum, pulp, paper, food and other industries.

Walworth polyvinyl chloride valves *and* fittings are molded to the *same* rigid Walworth specifications by the *same* molder—the General American Transportation Corporation—of the *same* basic material,—Geon rigid vinyl from B. F. Goodrich Chemical. Rigid plastic pipe of the same materials and made by the same molder is also available. Consistent performance is therefore assured throughout *all*-Walworth PVC piping systems. Plastic valves, fittings, and pipe offer the following advantages:

1. **Exceptionally resistant to most salts, alkalis, and nonoxidizing acids at temperatures below 150° F.**
2. **High burst strength and impact resistance.**
3. **Nontoxic, and extreme low flammability.**
4. **Easy to install.**

Get the complete Walworth PVC product story. Write for brochure containing detailed specifications, characteristics, and application data.

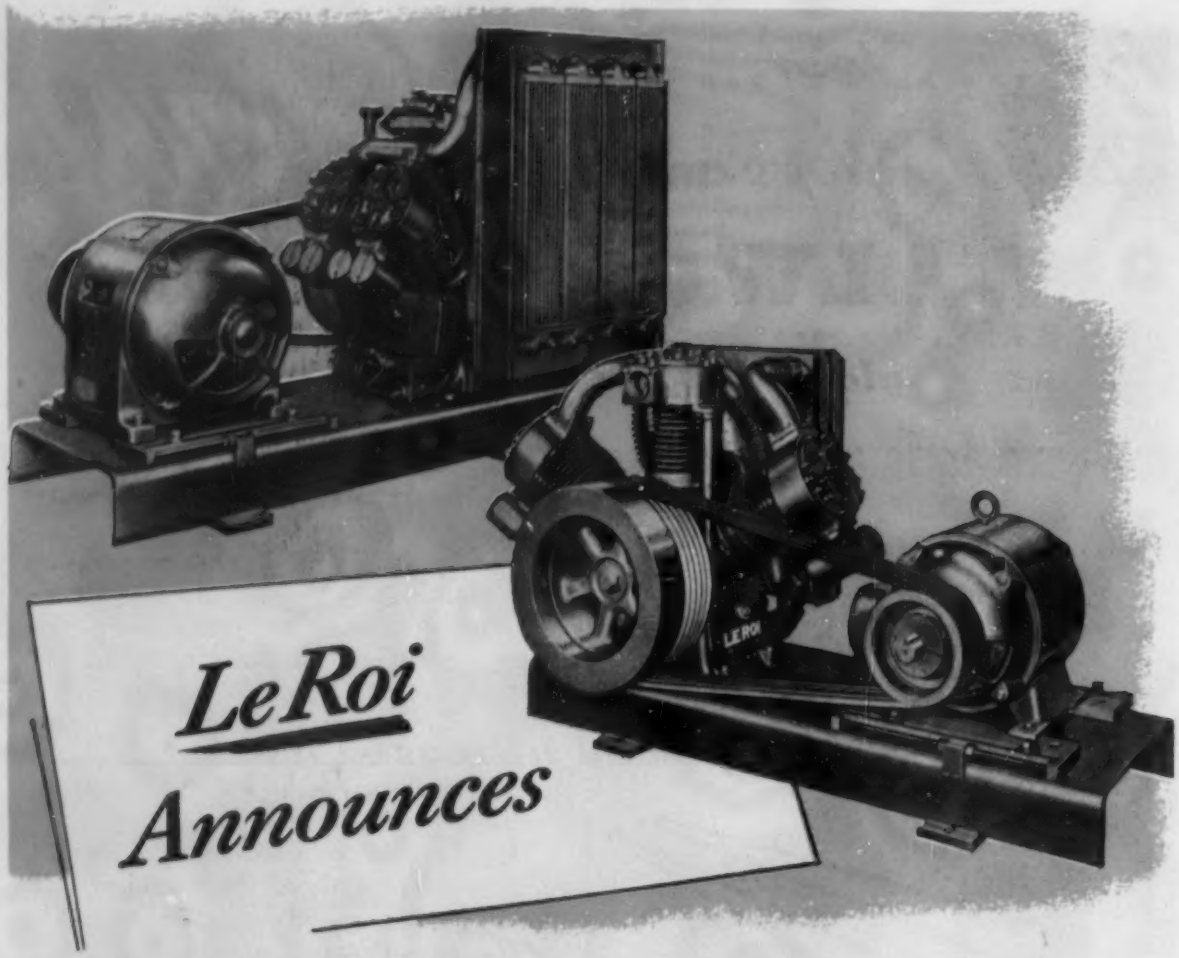
WALWORTH

valves . . . pipe fittings . . . pipe wrenches

60 East 42nd Street, New York 17, N. Y.

WALWORTH COMPANY OF CANADA, LTD.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD



Three New Stationary Compressors

Two-stage air-cooled units in 50, 75, and 100 hp. sizes having 200, 330, and 440 cfm capacities at 125 lbs. pressure

Now, Westinghouse Air Brake Co., through its Le Roi Division, adds three new compressors to its stationary line, giving you a size range from ½ to 100 hp. Built to give you years of service, these new compressors are designed to provide you with many important benefits—benefits that mean low-cost air for your plant, mine, quarry, ship, or construction job.

Low-cost operation — Good mechanical and compression efficiency resulting from 2-stage compression and intercooling keeps power costs to a minimum. Moreover, since these new Le Roi's are air-cooled, cooling-water cost is eliminated and attention on the part of the operator is greatly reduced.

Low-cost installation — Compact size reduces headroom and floor space requirements. Again, air cooling eliminates the need for water and water piping so that you can install these units practically anywhere with no fear of freezing. Minimum vibration and light weight lets you bolt them to a substantial floor and save on foundation costs.

Low-cost maintenance — All valves are interchangeable, both intake and discharge. Shrouded-type intercooler and large air passages promote longer valve life. No anti-freeze is required and there are no cylinder jackets or intercooler water passages to clog or scale. Forced-feed lubrication supplies oil under pressure to all moving parts and a sight-level oil gauge keeps the operator posted on the oil supply. The crankshaft is suspended on taper roller bearings that seldom need adjustment, and all parts are easily accessible.

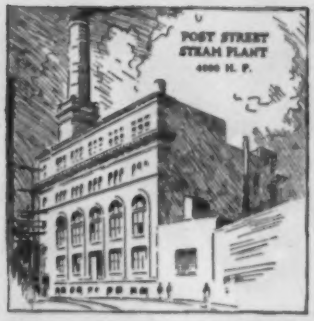
Dual control is standard equipment and permits either constant-speed or automatic start-and-stop regulation. Here's a practical answer to low-cost air supply. Write for our latest literature.

SC-100

LE ROI Division of Westinghouse Air Brake Co.

MILWAUKEE 14, WISCONSIN

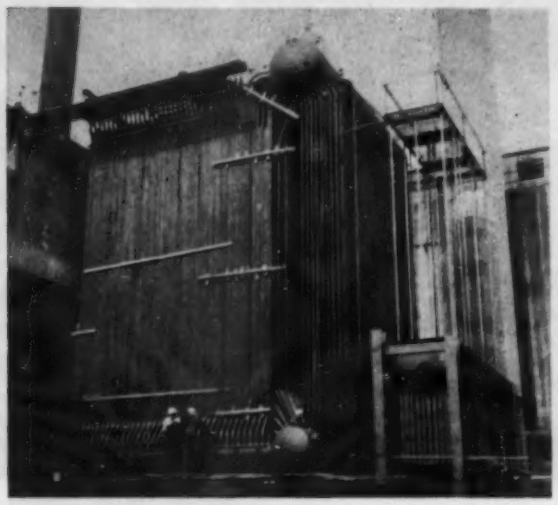
Distributors in all principal cities



GILSULATE®— The End of A Search

Old Post St. plant has 4,000 HP boiler capacity. Steam lines were originally encased in red cedarwood log conduits.

New Riley Boiler of Seattle Steam Corp. at their Western Ave. plant has 266,000 pounds per hour peak load; is set in weatherproof casing.

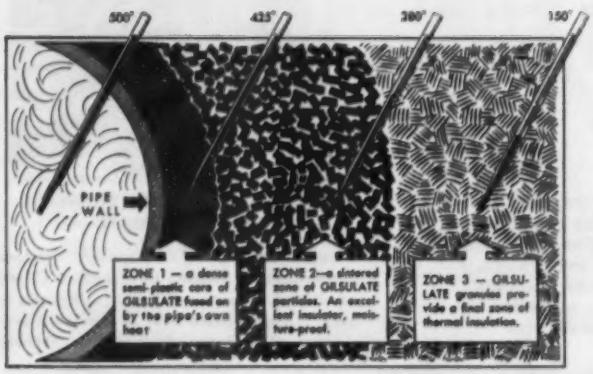


For more than half of a century, District Heating Companies have been seeking a way to prevent corrosion and reduce heat loss from underground steam mains. Many materials and techniques have been tried—unsuccessfully—spurred on by rising fuel prices and pipe replacement costs.

In 1952, Seattle Steam Corporation tried their first GILSULATE installation. So far, they have observed *complete corrosion protection and excellent insulating properties.* Is GILSULATE the end of the search?

Today this 18th largest of all American District Heating Companies orders GILSULATE in carload lots and maintains warehouse stocks for use on new lines, extensions and where a ditch is opened and existing facilities are exposed.

Investigate the values of this easily-installed, low-cost insulation yourself. Use the coupon below for complete information or write for the name of your nearest GILSULATE distributor.


500°
435°
380°
150°
PIPE WALL
ZONE 1 — a dense semi-plastic core of GILSULATE fused on by the pipe's own heat
ZONE 2—a sintered zone of GILSULATE particles. An excellent insulator, moisture-proof.
ZONE 3 — GILSULATE granules provide a final zone of thermal insulation.

Facts about Gilsulate

1. *Easy to use*—just pour, tamp and backfill...pipe heat does the rest.
2. *Forms 3 zones* of protection against heat loss and all hazards commonly encountered by hot buried pipes.
3. *Needs no housing or mechanical sheaths:* no mixing, special handling or equipment.
4. *Only needs normal pipe spacing:* for multiple pipe or cramped conditions.
5. *Three types available:*
   Type A for 220°-310° F. temp. range
   Type B for 300°-385° F. temp. range
   Type C for 385°-520° F. temp. range

THE TRIPLE-ZONE INSULATION FOR LIFETIME PROTECTION OF HOT UNDERGROUND PIPES

GILSULATE®

AMERICAN GILSONITE COMPANY, SALT LAKE CITY 1, UTAH
Affiliate of Barber Oil Corp. & Standard Oil Co. of California

American Gilsonite Co.
134-F West Broadway, Salt Lake City 1, Utah
or
1145 East Jersey St., Elizabeth, N. J.

Send me more information on GILSULATE Insulation

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TITLE .....

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ADDRESS .....

P

problems in water-conditioning . . .

VERSATILITY

Cochrane — *pioneer in*

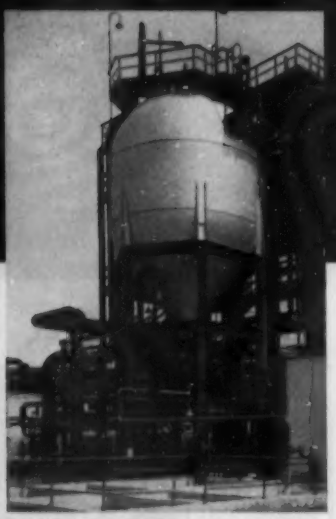
the versatile Hot Process

today leads in Hot Lime Zeolite

The Cochrane Hot Lime Zeolite Process is one of the most versatile of all water conditioning systems. Combining the advantages of the two most widely used water softening processes, Hot Process and Zeolite, the system is found equally effective on turbid surface supplies or clear well waters. It removes silica economically. Provision can be made for deaeration for both condensate and treated make-up. Cochrane Hot Zeolite units can be readily added to existing Hot Process Units—assuring higher effluent quality at lower treating costs by eliminating soda ash.

Cochrane Corporation designs and manufactures complete lines of deaeration, ion exchange, precipitation, and water conditioning equipment . . . Pioneers of the Hot Process, Cochrane today continues to lead in Hot Lime Zeolite. Consult Cochrane First!

For further information on Cochrane Hot Lime Zeolite Softeners, write for Publication 4801.



RICHFIELD OIL CHOOSES COCHRANE HOT LIME ZEOLITE

View of Richfield Oil Corporation's Hot Lime Zeolite Softener installed by Cochrane. Effluent alkalinity is reduced to 20 ppm . . . hardness to zero . . . silica reduced from 25 down to 3 ppm. Capacity of installation is 50,000 gallons per hour.

COCHRANE CORPORATION · WATER AND HEAT ENGINEERS · SINCE 1863 · PHILADELPHIA

Cochrane
CORPORATION

Representatives in 30 principal cities in U.S.; Toronto, Canada; Paris, France; La Spezia, Italy; Mexico City, Mexico; Havana, Cuba; Caracas, Venezuela; San Juan, Puerto Rico; Honolulu, Hawaii.
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Ad. 2.10

Let's get together on trap ratings!

WHEN ARNOLD BOGART tested some steam traps and found their capacities apparently well below the published ratings, he wanted to know why. He outlined his findings, and conclusions drawn from them, in a letter to POWER (published May 1955, p 140).

Here was a question of real concern to all engineers dealing with power and process equipment —a question calling for full clarification. So proofs of the published letter went to leading makers of steam traps, with POWER's invitation to discuss this important matter of ratings.

The letters published on pp 120, 121 of this issue point up the real complexity of this apparently simple business of testing and rating a trap's capacity. You'll want to read the details, but here are some highlights:

In essence, a steam trap consists of a valve and a mechanism for actuating it so the valve opens to pass condensate and closes to prevent loss of steam. Discharge capacity of a trap might thus seem to be simply a question of how much water will flow through a given opening with a given difference of pressure.

But first it must be remembered that a trap discharges only when condensate is present. So a test measures maximum capacity only if condensate is present during the entire period, with the valve fully open. And, most important, both test results and ratings are related to condensate temperature. Maximum flow occurs with cold water. At the higher temperature met in service, flow is less, both because of lower water density and the effects of the flashing that occurs.

It can be seen immediately that trap test results and published ratings can be misleading unless all the conditions are known and stated. Leading trap manufacturers recognize this and state the basis on which their published ratings are determined. When the user follows the maker's selection procedure and applies the recommended application factors, he gets the right answer for that make of trap. But we believe a further step is necessary.

The best interests of trap makers and users would both be served by agreement on a uniform basis of testing and rating. Such a standard would eliminate any possibility of confusion and would make it possible to compare trap ratings. The obvious benefits of standardization have been abundantly demonstrated in other technical areas where uniform methods have been adopted.

The letters in this issue indicate several bases for ratings. The one chosen should, of course, reflect average trap service conditions as closely as possible. But the important point is to arrive at a standard all can use.

We're confident the trap industry will develop such a standard. It has been and is being discussed. The vision and leadership are there—all we need is a concerted drive to the goal of uniform testing and rating methods. We offer POWER's help in reaching this goal and in making the results known to all power service engineers. They will welcome another standardization advance.

"We eliminated Motor Burnouts and cut new installation costs – by using Fusetron dual-element Fuses!"

"Our organization services some 43 Alfalfa Mills in the central Nebraska area.

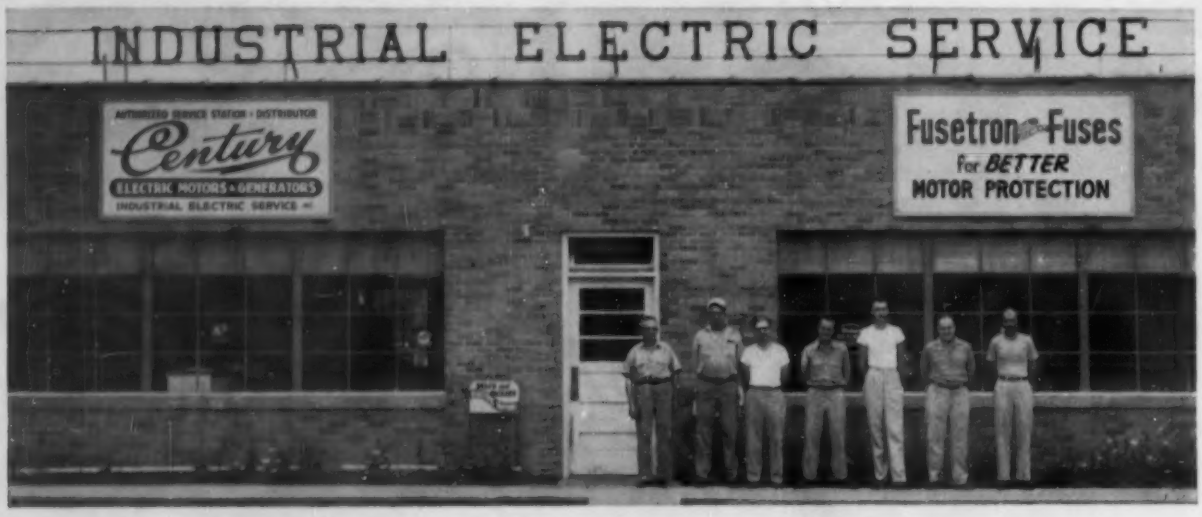
"We know, from experience, that overloads and single phasing are two of the most common causes for motor failures in these mills.

"In order to give these motors the protection they need, we use Fusetron fuses in motor-running protection sizes. As a result, we have eliminated motor burnouts for our customers.

"In addition, on new installations, we have found that smaller switches can be used with proper size Fusetron fuses.

"We can pass this substantial saving along to our customers and still give them safer protection than can be had with ordinary protective devices."

Max T. Moore, Vice-President
Industrial Electric Service, Inc.
Kearney, Nebraska



Here's why Fusetron dual-element fuses give DOUBLE protection to large motors

Of course, large motors are protected with thermal cutouts or overload relays. But experience has shown that such devices sometimes stick or fail to operate. When they do, the motor burns out.

On normal installations, by replacing fuses used for short-circuit protection with Fusetron fuses of motor-running protection size, you get the same short-circuit protection PLUS double protection against motor burnout from overload or single phasing.

If thermals or relays fail to operate for any reason, the Fusetron fuses will act independently to SAVE THE MOTOR.

And Fusetron fuses protect against waste of space and money — permit use of proper size panels and switches.

On motor circuits Fusetron fuses can be used in sizes near to the operating load. That cannot be done with ordinary fuses. It is possible with Fusetron fuses because they have a tremendous time-lag that prevents them from opening on starting currents or other harmless overloads.

This means that on new installations for motor circuits you can save space and money because *proper* size Fusetron fuses permit using *proper* size switches and panels instead of *oversize*.

You too, can profit by the 10 point protection of Fusetron fuses

1. High interrupting capacity — protect against heaviest short-circuits. Have proven on tests to open safely on circuits set to deliver in excess of 100,000 amperes.
2. Protect against needless blows caused by excessive heating — lesser resistance results in cooler operation.
3. Protect against needless blows caused by harmless overloads.
4. Provide thermal protection — for panels and switches against damage from heating due to poor contact.
5. **Protect against waste of space and money — permit use of proper size switches and panels.**
6. **Protect motors against burnout from overloads.**
7. **Give DOUBLE burnout protection to large motors — without extra cost.**
8. **Protect motors against burnout due to single phasing.**
9. Make protection of small motors simple and inexpensive.
10. Protect coils, transformers and solenoids against burnout.

For more information on Fusetron fuses write for bulletin FIS.

On new construction, tell your architect to specify this Safer, Better Protection.

FOR LOADS ABOVE 600 AND UP TO 5,000 AMPS . . . USE BUSS HI-CAP FUSES

They have unlimited interrupting capacity to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuit of origin.

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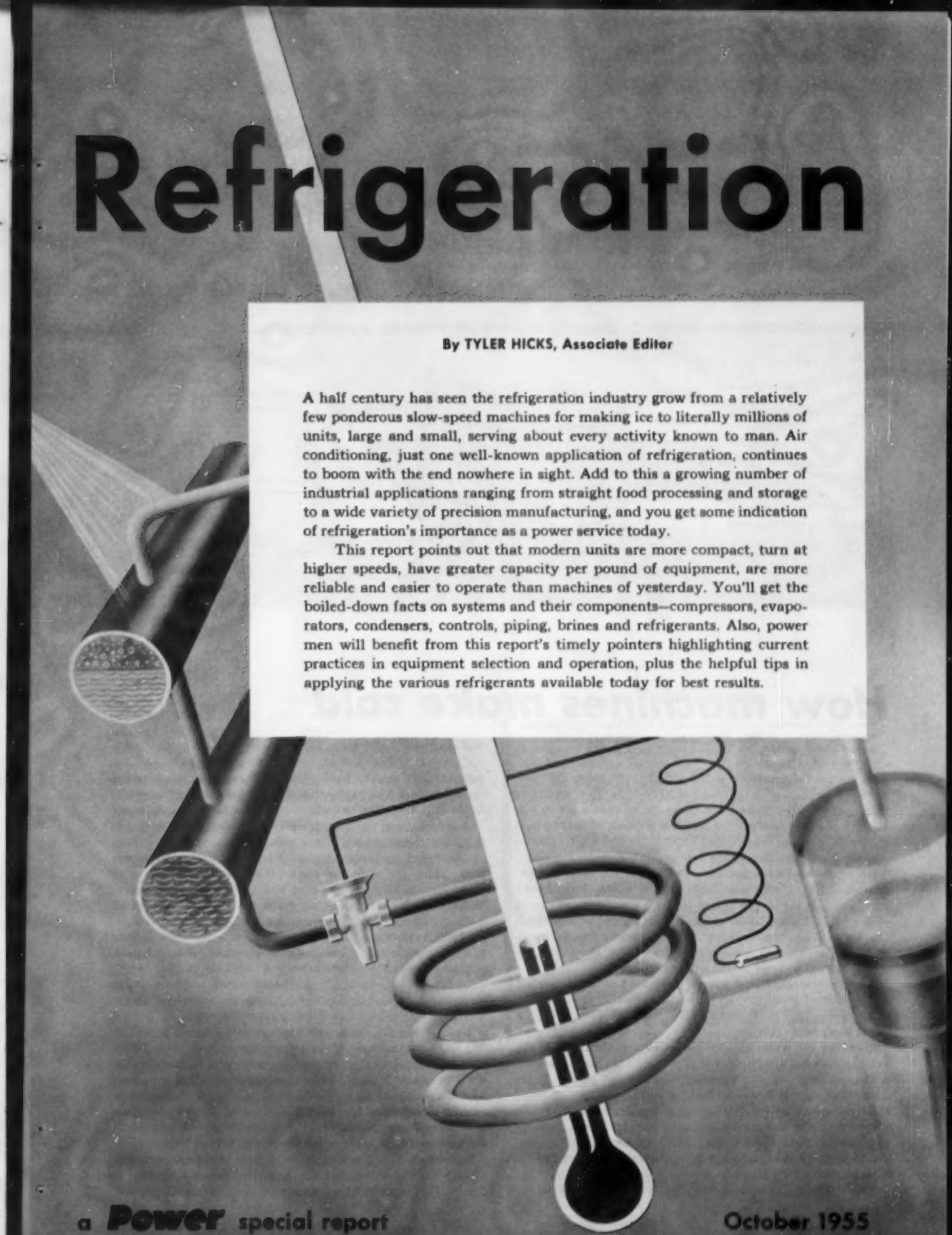
Refrigeration



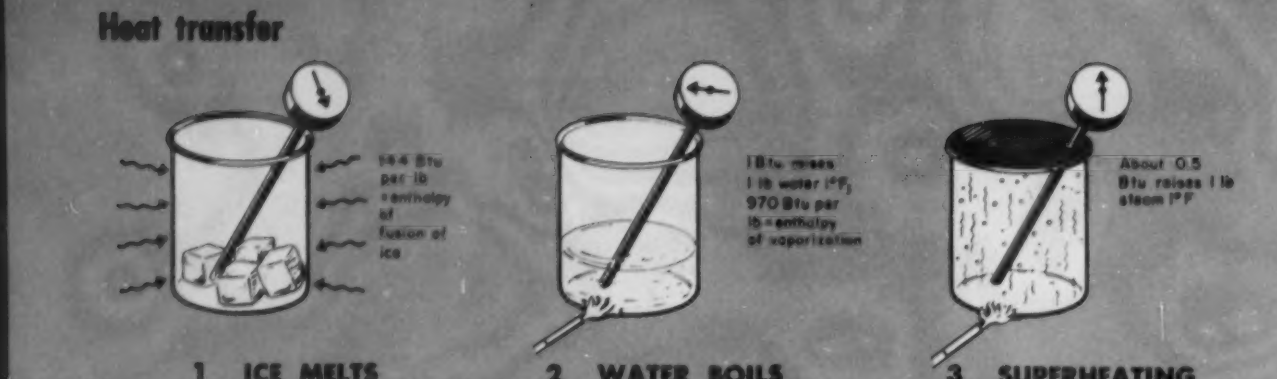
By TYLER HICKS, Associate Editor

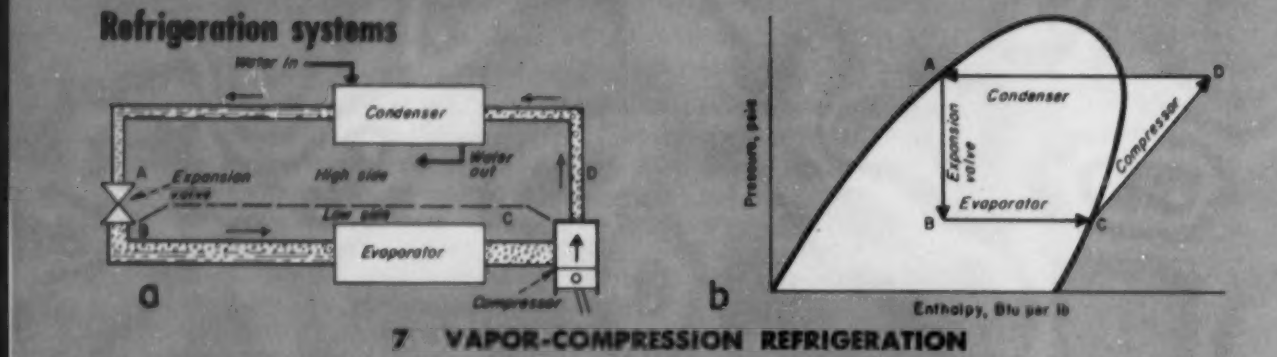
A half century has seen the refrigeration industry grow from a relatively few ponderous slow-speed machines for making ice to literally millions of units, large and small, serving about every activity known to man. Air conditioning, just one well-known application of refrigeration, continues to boom with the end nowhere in sight. Add to this a growing number of industrial applications ranging from straight food processing and storage to a wide variety of precision manufacturing, and you get some indication of refrigeration's importance as a power service today.

This report points out that modern units are more compact, turn at higher speeds, have greater capacity per pound of equipment, are more reliable and easier to operate than machines of yesterday. You'll get the boiled-down facts on systems and their components—compressors, evaporators, condensers, controls, piping, brines and refrigerants. Also, power men will benefit from this report's timely pointers highlighting current practices in equipment selection and operation, plus the helpful tips in applying the various refrigerants available today for best results.

a **Power** special report

October 1955


Heat transfer
144 Btu per lb = enthalpy of fusion of ice
1 Btu raises 1 lb water 1°F, 970 Btu per lb = enthalpy of vaporization
About 0.5 Btu raises 1 lb steam 1°F
1 ICE MELTS
2 WATER BOILS
3 SUPERHEATING



How machines make cold

Making cold depends on a few simple principles. Of these the most important is that heat always flows from a warmer to a cooler body—never the reverse. So to cool a warm object we place it near a cold one like a block of ice, or in a cold well, pond or lake. Using natural ice and cold water to remove heat provided man's first cooling systems.

Heat flow. Put some ice cubes in a jar with a thermometer, Fig. 1, and heat flowing from the room and surrounding air melts the cubes if the room temperature is above 32 F. To melt 1 lb of ice, 144 Btu must be absorbed. During melting, temperature of ice and water formed stays at 32 F. Conceivably, we could cool an entire room with ice cubes, but the process would not be efficient.

If a concentrated heat source is applied to a jar, Fig. 2, water formed from the ice cubes boils when it reaches a temperature of 212 F. Once again, heat is flowing from a warm body to a cooler one.

To make the water change to steam, a gaslike vapor, we must add about 970 Btu per lb of water. This heat quantity is the *enthalpy of vaporization*. During the period when water is changing to steam, there is no temperature change. Heat absorbed by ice in melting is *enthalpy of fusion*.

When all the water changes to steam at 212 F, further addition of heat causes superheating, meaning that the temperature of the steam is higher than that corresponding to its pressure, Fig. 3.

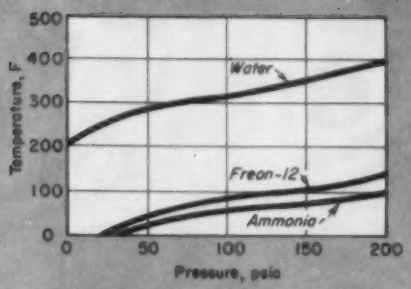
Vaporization, condensation. Water boils at 212 F when subjected to atmospheric pressure. Increasing the pressure on surface of a liquid raises the temperature at which it boils. Curves, Fig. 4, show some boiling temperatures.

Condensation, the reverse of vaporization, also occurs at constant temperature. For a given pressure of the liquid, condensaton occurs at the same temperature as vaporization. Thus, for water at atmospheric pressure (14.7 psia) vaporization or boiling occurs at 212 F, as does condensation. Reducing the pressure to 1 in. Hg absolute gives boiling and condensation temperatures of 79 F.

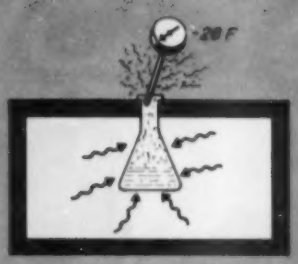
Refrigerants are fluids that, with few exceptions, boil at low temperatures at atmospheric pressure. For example, ammonia at 14.7 psia boils at −28 F, while F-12 (Freon-12) boils at about −21 F, at the same pressure. Boiling and condensation processes of refrigerants are the same as for water.

Using these concepts, let's arrange an insulated box as in Fig. 5, with a flask of ammonia suspended in it. With normal atmospheric pressure on the ammonia surface, the liquid boils at −28 F, absorbing about 602 Btu per lb of liquid vaporized. Since little heat can pass through the insulated sides of the box, heat needed for vaporization will come from the air or other contents of the box. Thus we have a crude system for producing refrigeration.

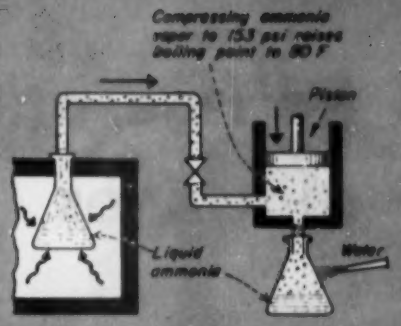
System in Fig. 5 might find use were refrigerants cheap, readily obtained from nature and noninjurious to human beings. But most refrigerants are not, and even if they were,



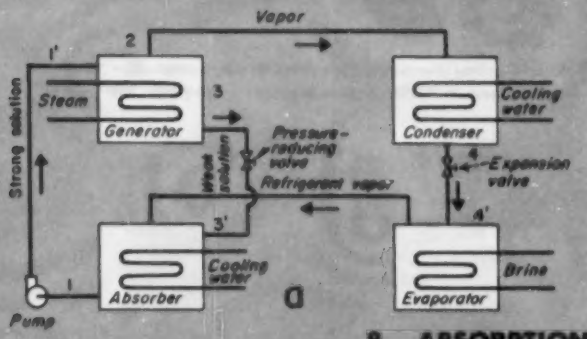
4 PRESSURE AND BOILING

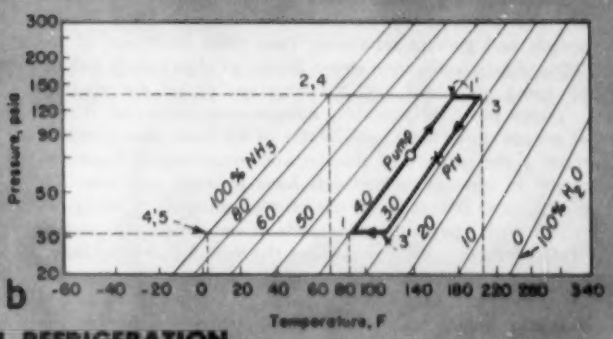


5 BOILING AMMONIA



6 RECOVERING AMMONIA





8 ABSORPTION REFRIGERATION

the hookup, Fig. 5, is impractical. So to make our system practical, we must find some way of recovering the ammonia vapor after it has absorbed heat.

We could arrange to suck it into another chamber, but to condense it we'd need, as we recall from Fig. 2 and 3, a cooling medium at a temperature less than −28 F because condensation occurs at the same temperature as boiling.

Since condensation temperature depends on vapor pressure, if we compress ammonia to a high enough pressure we can condense it by cooling with air or water at ordinary atmospheric temperatures (40 to 70 F). Fig. 6 shows how this can be done, using water for cooling.

Compression system. Fig. 6 can be further refined to that shown in Fig. 7a, where an expansion valve controls refrigerant flow from *high* to *low* side. Fig. 7b shows a pressure-enthalpy (Ph) diagram for the system in Fig. 7. Starting at the expansion-valve inlet *A*, refrigerant in the liquid state flows through the valve, a portion of it changing to a vapor. From *B* to *C* the liquid is vaporized in the evaporator (corresponding to the flask). Compression is from *C* to *D*, desuperheating and condensation from *D* to *A*.

Compression systems may use reciprocating, centrifugal, gear or rotary compressors and any one or more of a variety of refrigerants, depending on the job.

Steam-jet units are also the compression type. They use water as their refrigerant, have steam jets to lower the pressure, reducing the boiling point of the water.

Absorption system. Here, heat is used to raise pressure of the refrigerant, instead of a compressor. Fig. 8a shows the components of a typical system. Absorption refrigeration relies on ability of some liquids and solids to absorb vapors when cold, give them up when hot.

DEFINITIONS

REFRIGERATING EFFECT is the amount of heat absorbed in the evaporator, which equals that removed from space cooled. It is measured by subtracting the enthalpy (heat content) of one pound of refrigerant entering expansion valve from the enthalpy of the same pound leaving evaporator

TON OF REFRIGERATION is about equivalent to melting one ton of ice in 24 hr, or 288,000 Btu per 24 hr; 12,000 Btu per hr; 200 Btu per min

REFRIGERANT HANDLED in pounds per ton-minute is found by dividing 200 Btu per min by the refrigerating effect, Btu per lb of refrigerant

WORK OF COMPRESSION is amount of heat added to refrigerant in compressor. Measured by subtracting enthalpy of one pound of refrigerant at suction from enthalpy of same pound at the compressor discharge

COEFFICIENT OF PERFORMANCE is the ratio of refrigerating effect to work of compression. A high coefficient of performance means high efficiency of the refrigeration cycle

HORSEPOWER PER TON is mechanical input in horsepower, divided by tons of refrigerating effect produced by unit

STANDARD-TON CONDITIONS specify the pressures a machine must operate at to have certain evaporator and condenser temperatures—for example, 5 and 86 F, respectively. Tonnage produced at these temperatures is standard rating of the machine. Other temperatures are also used

A common combination is ammonia as refrigerant, and water as *absorbent* or *solvent*. In Fig. 8a, refrigerant gas from evaporator is absorbed by water in the absorber. Heat, applied in the generator, drives off ammonia at condenser pressure. Fig. 8b is a simple cycle diagram for the system.

Refrigeration machines

Shown on these two pages are a few of the many different designs for refrigeration machines of various types. There is far wider variation in the designs of machines for compression systems—reciprocating, rotary, gear and centrifugal — than for absorption and steam-jet systems.

Reciprocating compressors of modern design, Fig. 1-6, are characterized by smaller size, lighter weight, higher speeds and greater reliability than their forebears of the 1900s. Early units were steam driven at slow speeds (about 50 rpm) and used liquid refrigerant or oil for cooling.

Today most reciprocating compressors are motor driven at speeds up to 3600 rpm. Water or air cools the cylinders, making the entire unit simpler and more rugged. Improvements in production methods have lowered unit cost, enabling more industries to use greater amounts of refrigeration in their operations. Complete or semiautomatic control of compressor operation reduces the amount of attendance.

Hermetically sealed reciprocating and rotary compressors have the compressing element and drive motor sealed in a single housing. Relatively new, they are finding increasing use in a wide variety of applications. Advantages include elimination of the shaft seal of the open-type unit, easier lubrication and less operating noise. Some designs are cooled by refrigerant gas entering compressor.

Centrifugal refrigeration compressors, introduced commercially about 30 years ago, are characterized by large capacity, suitability for extremely low temperatures and ability to carry varying loads with satisfactory efficiency at all loads within their operating range.

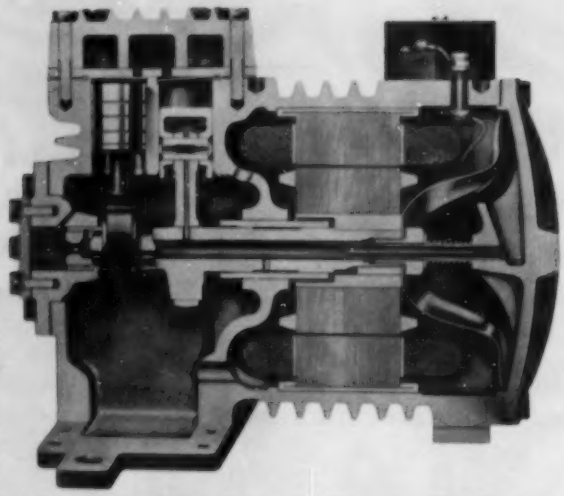
Essentially high-speed units, centrifugal compressors may be directly driven by steam turbines. Motor or internal-combustion-engine drive is also used. Top speed of these compressors today is about 8000 rpm. While many standard model centrifugal compressors are available, it is not uncommon to design and build some units for a specific job, selecting one of a large number of suitable refrigerants.

Absorption machines, making a comeback after many years' neglect, are catching on fast for air-conditioning and process jobs. With steam as their source of heat, they can provide a summer load leading to advantageous steam rates. Other advantages include quiet operation, light weight, easy control.

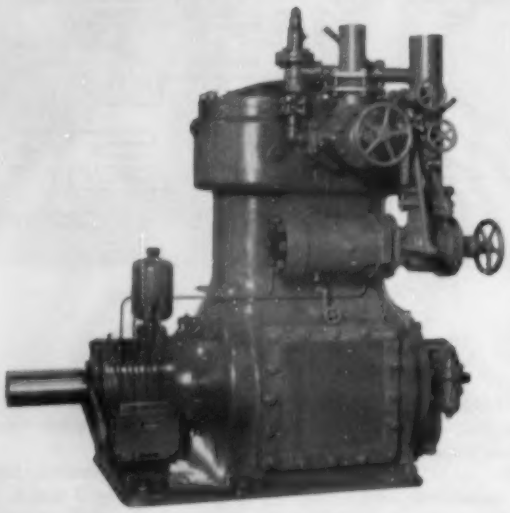
Steam-jet units, using only steam and water, are simple, safe and low-cost, supply chilled water at 35 F, or above.

OTHER METHODS

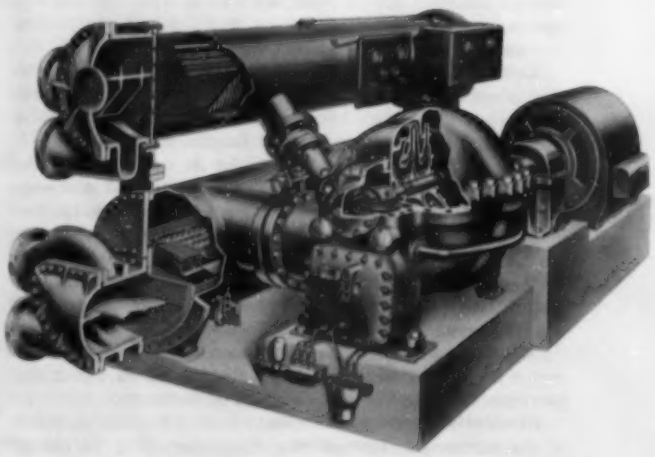
Today, practically all of industry's cooling is produced by one or more machines of the types shown on these two pages. But some aircraft have air-cycle units for cabin cooling. Magnetic cooling, using paramagnetic salts, produces low temperatures by adiabatic demagnetization of the salt. Electronic cooling, based on the Peltier effect, consists of a series of junctions made of copper and zinc alloys. These surround a container. Electric current produces cooling at one junction. At present, both these methods are still in the laboratory stage.



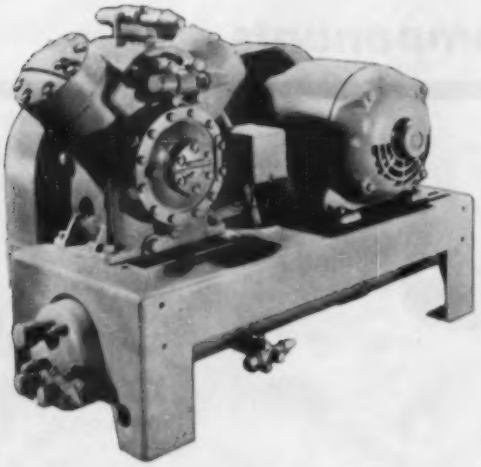
1 Single-acting hermetically sealed Freon compressor can be maintained in field, has capacities to 110,000 Btu per hr



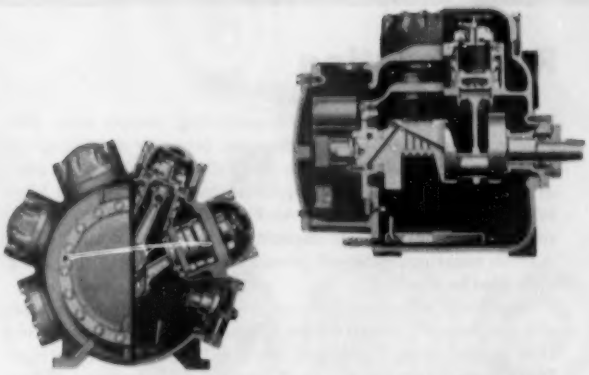
4 Twin-cylinder ammonia compressor for 5 to 100 tons is a typical unit for this refrigerant; belt or direct drive



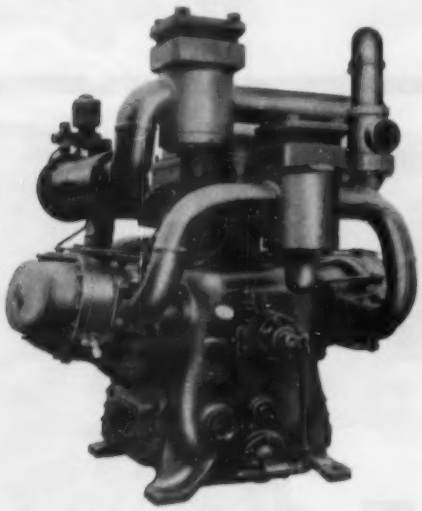
7 Centrifugal refrigerating machines of this design chill brines to —150 F, are built in capacities to 3000 tons



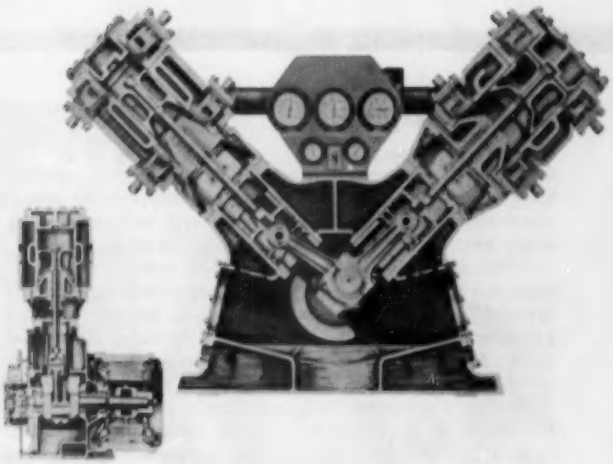
2 Built with two or three cylinders, Freon-12 units like this one are designed for loads of 3, 5, 7.5 and 10 tons



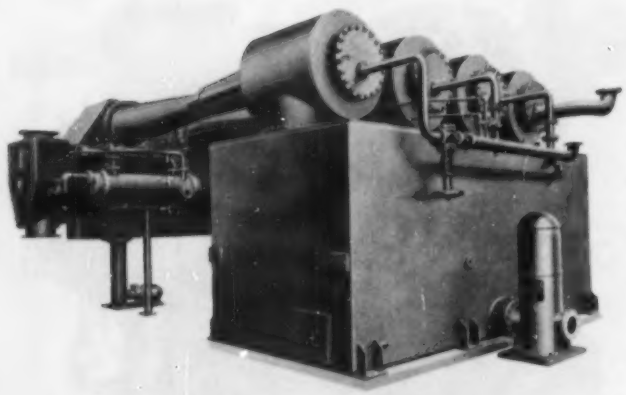
3 Built with 4, 6 or 8 cylinders in V, W or VV arrangement, single units have 10- to 50-ton capacity on Freon 12, 22



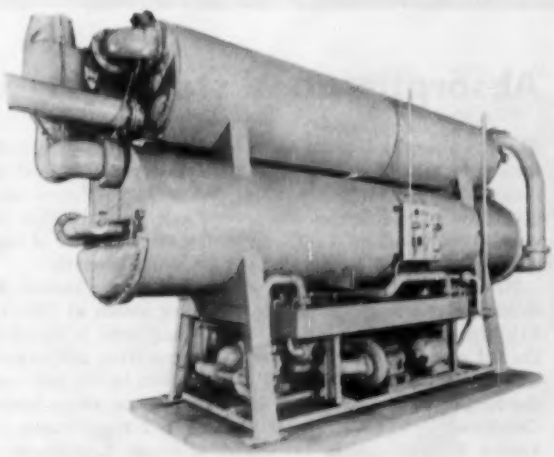
5 Booster compressor handles large gas volumes at low pressure in low-temperature systems, acting as the first stage



6 Y-type ammonia compressor is built as a single- or two-stage double-acting unit with integral motor on the shaft



8 Steam-jet refrigeration unit uses water for its refrigerant, delivers 35-F or higher temperature chilled water



9 Absorption refrigerating machine uses steam or hot liquid with lithium-bromide absorbent: compact, vibration-free

Refrigeration-machine components

Reciprocating

Higher speeds for today's reciprocating compressors give greater displacement, produce more capacity from a given bore and stroke. Freon compressor, disassembled at **A**, runs at 1750 rpm, uses lightweight reciprocating parts. Unit takes 0.99 hp per ton at 40-F-suction, 105-F-condenser temperature. Multistep capacity control is actuated by suction pressure; external pneumatic or electrical triggering may also be used.

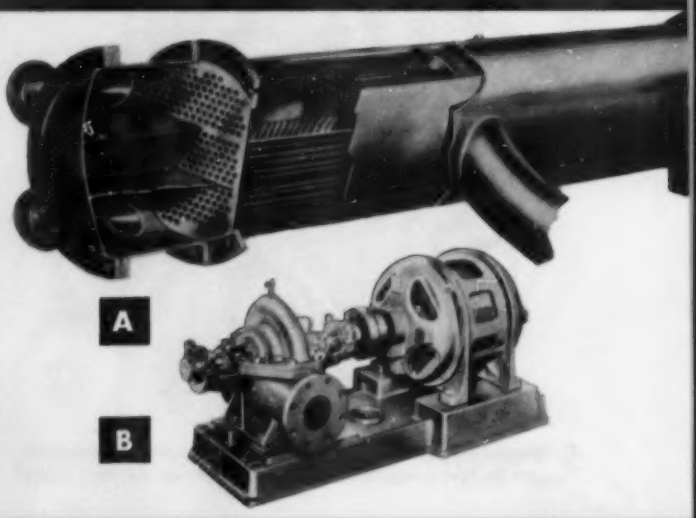
Ammonia compressor components **B** through **F** are usually of heavier construction than for Freon. Connecting rods **B** are often die-forged steel with precision-bearings. Plate-type discharge valves **C** operate on a pressure differential. Poppet and strip-type valves are also used. Suction valves **F** are in compressor head, along with the discharge valves, or in piston top. A typical piston for a high-speed ammonia compressor is shown at **D**; crankshaft at **E**.

Centrifugal

Centrifugal compressors raise refrigerant pressure in steps through each stage, usually are built as complete units with compressor, condenser, cooler, drive and auxiliaries on a single base, making a compact, high-capacity package.

Divided-waterbox multiple-pass shell-and-tube condensers **A** are used. Refrigeration machines of this type almost invariably chill water or brine, which is circulated to the points where cooling is required. One or more centrifugal pumps **B** circulate the water or brine to be chilled through the shell-and-tube cooler **C**.

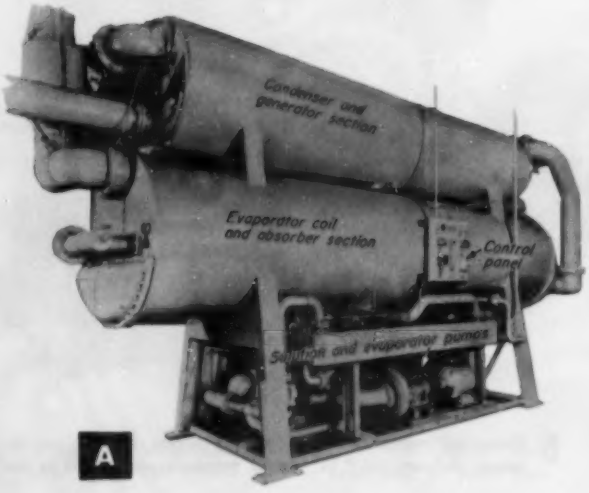
To reduce power input to compressor, an interstage flash chamber **D** may be used between the condenser and cooler. In this chamber a portion of the refrigerant flashes into vapor, subcooling the liquid refrigerant. Most centrifugal machines also have a noncondensable-gas purge system.

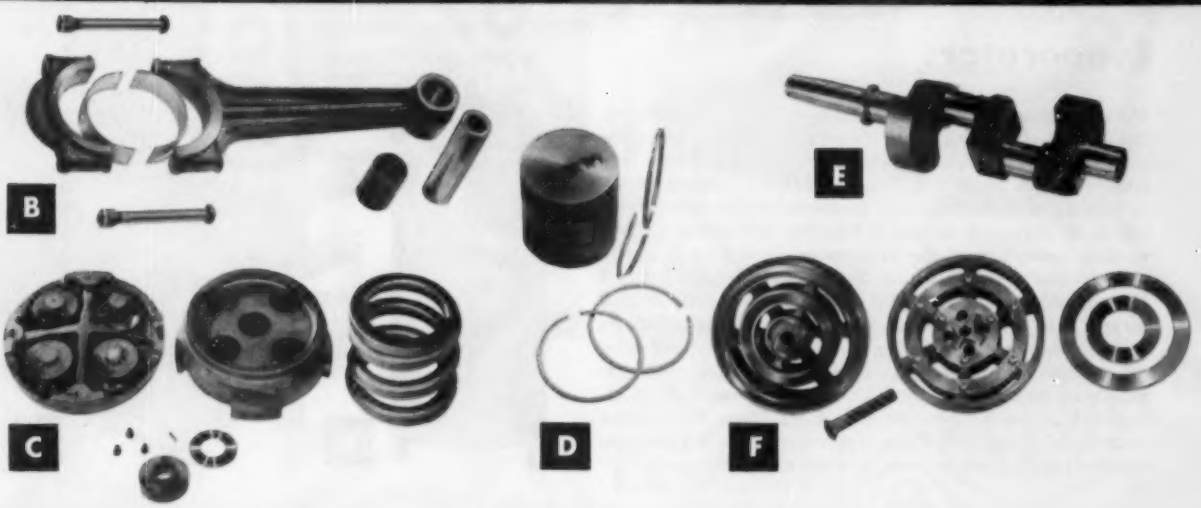


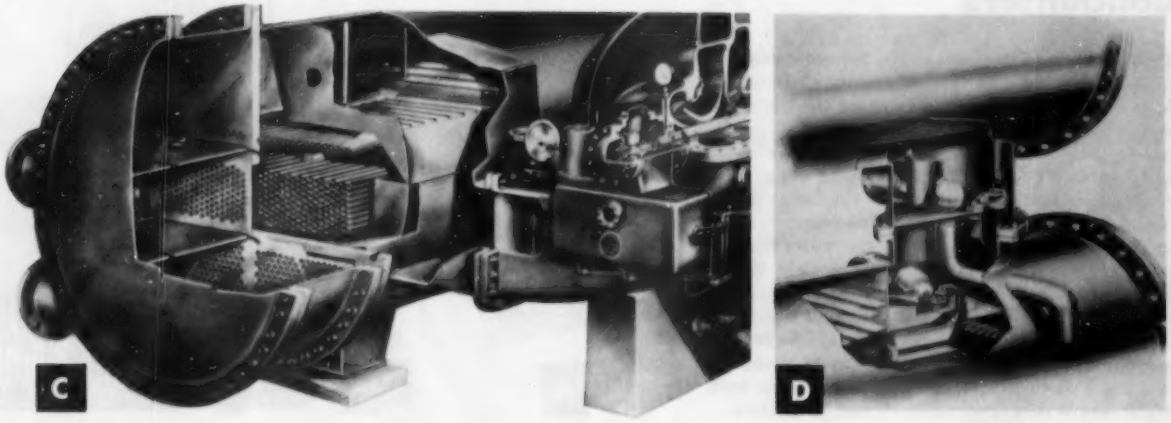
Absorption and steam-jet

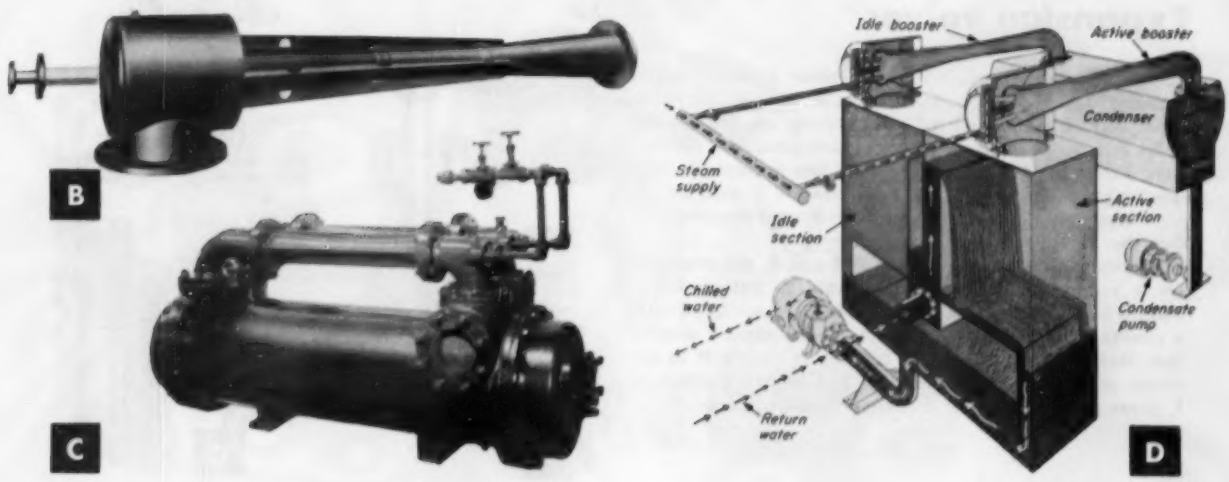
Modern absorption units are a far cry from the early collection of tanks, pipes and coils of yesteryear. Typical of today's designs, the machine at **A** has its condenser and generator in a single vessel, evaporator and absorber in another vessel. Both are supported by the same set of legs with solution and evaporator pumps slung beneath.

Heart of a steam-jet refrigeration unit is the booster **B**. It has several steam nozzles discharging steam at 3500 to 4250 fps across a suction chamber and into a venturi-shaped compression tube **D**. Water vapor from evaporator enters booster suction where it is entrained by the jets and discharged to the diffuser; here compression takes place. Condenser vacuum is maintained by a 2-stage steam-jet ejector **C**. For special installations, where high-pressure steam is not available, vacuum pumps are used.




B
C
D
E
F

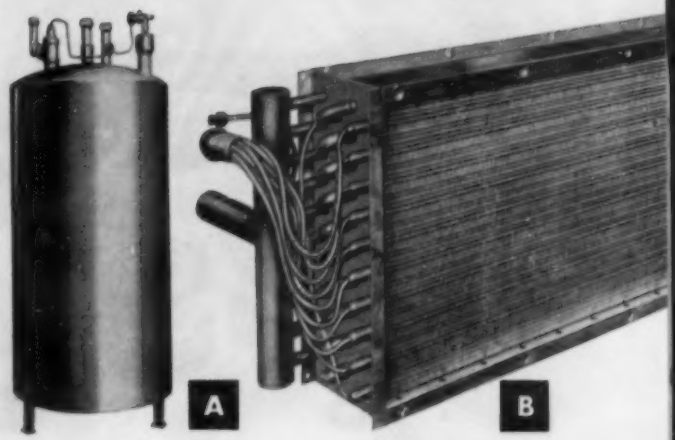

C
D


B
C
Idle booster
Active booster
Condenser
Steam supply
Idle section
Active section
Chilled water
Condensate pump
Return water
D

System components

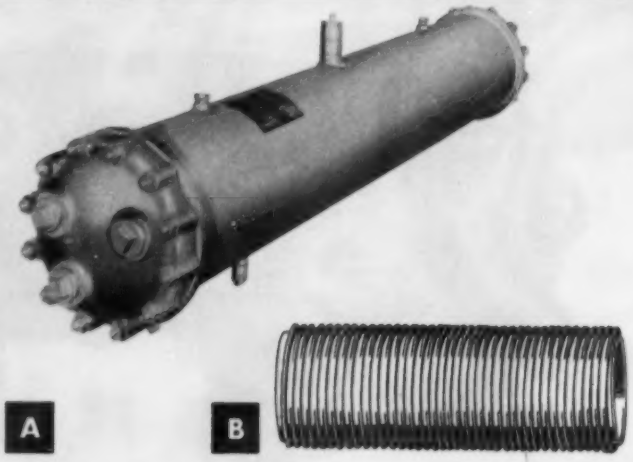
Evaporators

Many different types of evaporators are used, depending on the job. Watercooling type **A** supplies cooled water for indirect air-conditioning systems, is built for Freon in a wide range of capacities. Direct-expansion cooling coil **B** is fed just enough refrigerant by the expansion valve so all liquid is converted to gas before the refrigerant reaches suction connection of the evaporator. This type is widely adopted for air-conditioning ducts. Cascade-type chiller **E** is a double-pipe unit fitted with a spring-type bladed scraper **C** to keep pipe clean. Liquid to be cooled circulates through the inner pipes, refrigerant between inner and outer pipes. Motor rotates scrapers. Shell-and-tube dry- or direct-expansion liquid chiller using Freon is shown at **D**. Vertical-header-type coil **F** for can-ice plants, may have float control or thermal-valve feed. Plate-type evaporators **G** have continuous loops of steel tubing between evacuated plates.



Condensers

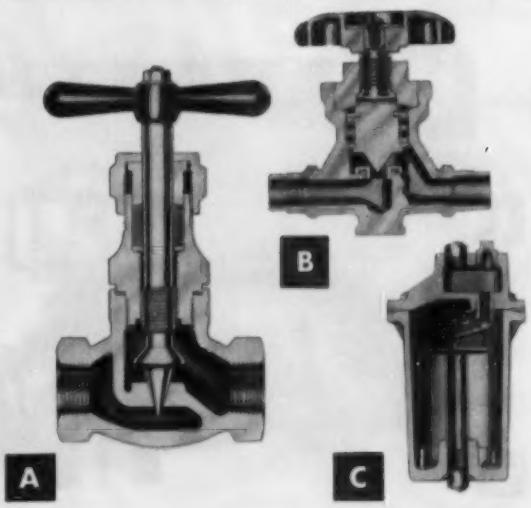
Shell-and-tube Freon condenser, the most widely used type for this refrigerant in larger-capacity systems, is shown at **A**. It has finned tubes **B** to increase the heat-transfer area and efficiency. There may be either two or four water passes, depending on job. Older ammonia systems often had double-pipe condensers but these are gradually being replaced by shell-and-tube units similar to **A**, either horizontal or vertical construction. The condenser-tower unit **C** is designed to meet the need for water conservation in industry. It consists of a multipass straight-tube condenser, a receiver, oil trap, water pump and cooling tower. Air-cooled condensers **D** are used for small units, up to about 3 hp. Larger capacities almost always have watercooling, sometimes in newer double-pipe units. Evaporative condensers **E** receive their cooling effect from both air and water, are widely used in small and large sizes.

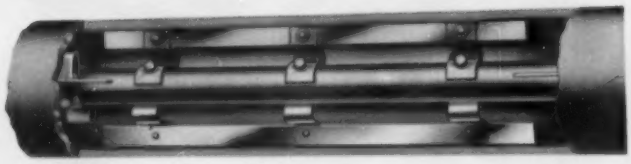


Expansion valves

Hand-expansion valves still find a place in some larger systems. Globe-type ammonia valve **A** is built for hand expansion of refrigerants or for metering service. Needle point and fine-pitch stem threads allow close flow regulation. Freon hand-expansion valve **B** has multiple metal-diaphragm sealing. Inverted bucket trap **C** is used as an expansion valve in some systems with flooded evaporators; can also be applied for liquid-seal service.

Thermostatic expansion valves **D**, **E** and **G**, are available for a number of different refrigerants to automatically control liquid flow into the evaporator. They are fitted with a remote thermal bulb clamped to the compressor suction line. Bulb actuates the valve, opening or closing it to increase or decrease refrigerant flow. Refrigerant distributor, **F**, gives equal feeding to multicircuit evaporators.





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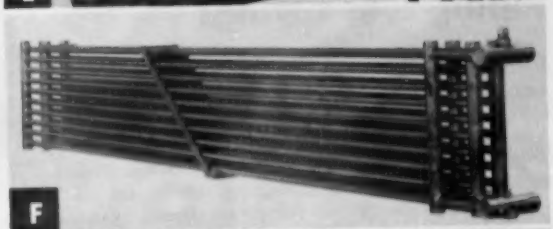

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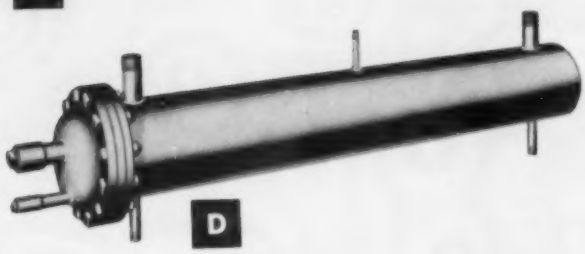

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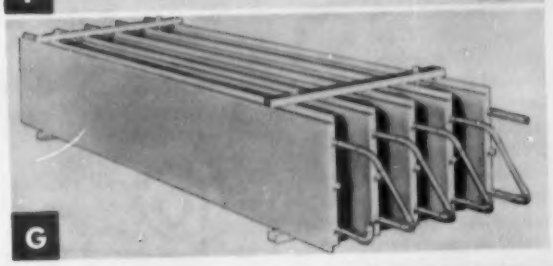

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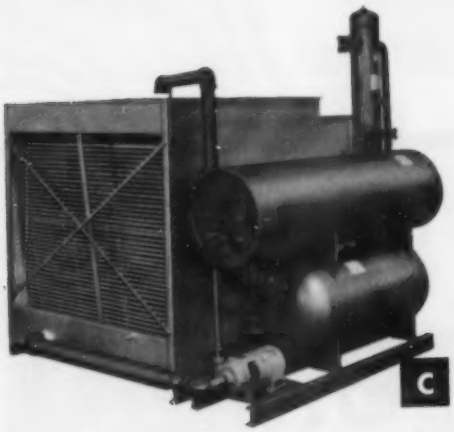

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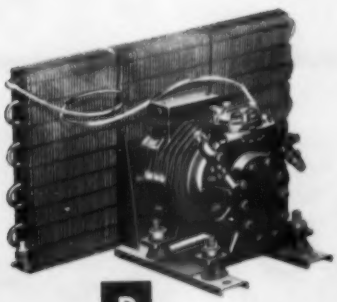

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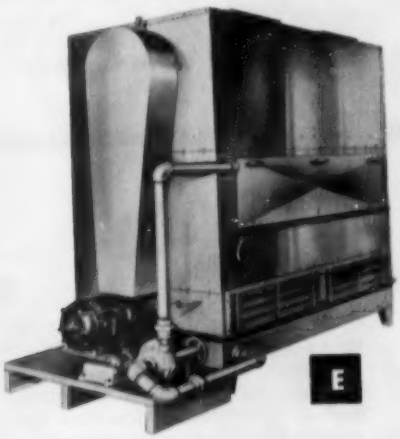

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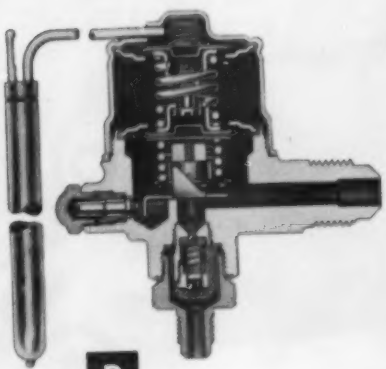
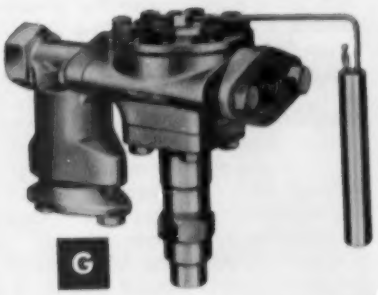


D

E



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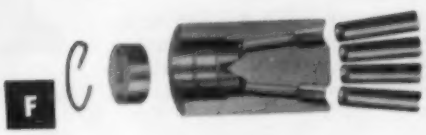


F

Piping and fittings

Piping materials for refrigerants, brine and water include steel, wrought iron, malleable iron, cast iron, brass, copper and bronze. Piping is made to specifications approved by American Standards Association *Code for Pressure Piping*, ASA B31.1, table, *right*. Ammonia systems use ferrous pipe; types *K* and *L* copper tubing are often used for Freon.

Valves and fittings for refrigerant piping systems come in a large number of different types, some of which are shown here. Line shutoff valves must give safe, tight closure. Diaphragm packless valves **1**, with flare or solder connections, are popular for Freon. Ammonia valves **2** have extra-long packing glands to prevent leaks; backseating permits repacking under pressure. Relief valves **3** protect equipment from excessive pressure.

Because Freon refrigerants are good solvents, they remove sludge, chips, rust, etc, from inner walls of pipes and equipment. For this reason, filters **4** and **7** are often located in pipe lines. Driers **5** and **8** are packed with a dehydrating agent to remove moisture from the refrigerant. Economizers **6** and **9** use suction gas to subcool liquid refrigerant on its way to the expansion valve.

Other important fittings, for whose illustrations we do not have room, include oil separators, mufflers, liquid receivers, strainers, sight glasses, fusible plugs, check valves, receiver valves, compressor shutoff valves, purgers, etc.

Materials for refrigeration piping

Material	Specification	Allowable stress, internal, psi
Steel, seamless, Grade A	ASTM A53, A120, A106 A83, A179, A192 or API 5L	12,000
Steel, seamless, Grade B	ASTM A53, A106 or A210	15,000
Steel, seamless alloy, Grades T18, T19	ASTM A213	18,750
Steel, electric-resistance welded, alloy, Grades T18, T19	ASTM A249	15,900
Steel, lap welded	ASTM A53, A106, A120 or API 5L	9,000
Steel, butt welded	ASTM A53 or A120	6,800
Steel, electric-resistance welded	ASTM A135, A178, A214 or A226	10,200
Wrought iron, lap welded	ASTM A72 or API 5L	8,000
Wrought iron, butt welded	ASTM A72	6,000
Cast iron, pit cast	AWWA	4,000
Cast iron*	FSEC WW-P-421	6,000
Brass, seamless, red brass	ASTM B43	4,700
Copper, seamless	ASTM B42	4,000
Copper tubing, seamless	ASTM B88	4,000

*Centrifugally cast or cast horizontally in green-sand molds

Controls

A variety of control devices are required for industrial systems since they have to meet many different load situations.

Capacity control **10** is the pneumatic step type; it provides: (1) on-off operation of steps in sequence (2) positive prevention of starting more than one compressor at a time after night shutdown or current failure (3) manual or automatic changing of operating sequence to equalize wear. Some compressors have pockets for varying unit capacity.

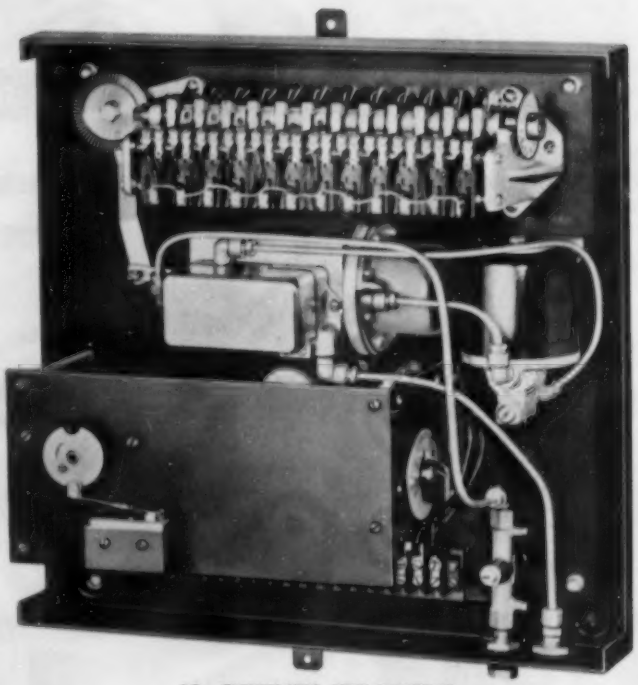
Pressure controller **11** starts and stops the compressor in response to machine suction pressure. This provides good control, especially when load is constant, or nearly so.

Condensing-water regulating valve **12**, installed in the condenser water-supply line, is actuated by high-side pressure or temperature. When pressure or temperature rises, the valve opens wider, admitting more water to condenser. Spring closes valve when temperature or pressure falls.

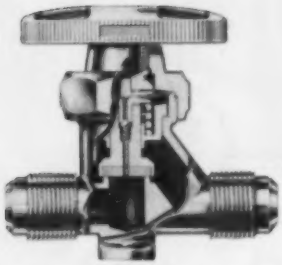
Evaporator pressure regulator **13** is a spring-loaded pressure-operated valve installed in suction line to maintain the evaporator pressure at a constant value. It prevents coil frosting, chiller freeze-ups, etc.

Solenoid stop valves **14** provide a means of stopping refrigerant gas or liquid flow in response to action of thermostat or pressure control. They control flow to expansion valves, coils and compressors.

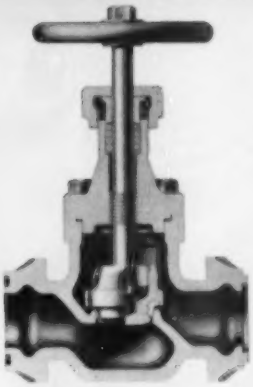
Float control **15** has a mercury switch for high or low liquid-level alarm, pump control on surge drums, receivers, tanks, etc. Room thermostat **16** opens or closes an electric circuit in response to room-temperature change, can actuate a relay to start compressor.



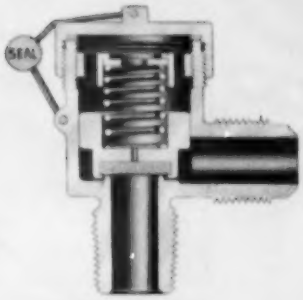
10 PNEUMATIC STEP-CONTROL



1 PACKLESS VALVE

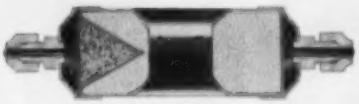


2 AMMONIA VALVE



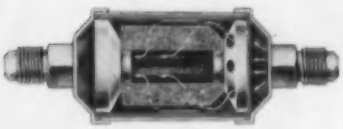
3 RELIEF-VALVE

4 FILTER-STRAINER



5 NONREFILLABLE DRIER

6 FIN-TYPE ECONOMIZER

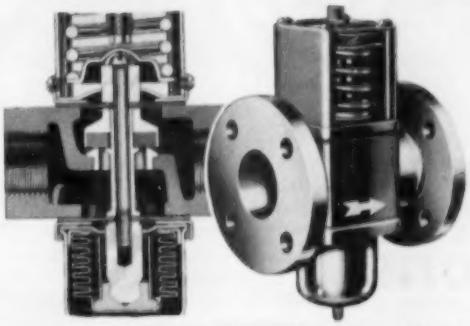


7 WOOL-FIBER FILTER

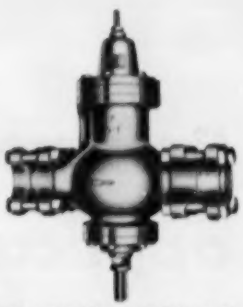
8 REPLACEABLE DRIER

9 COIL-TYPE ECONOMIZER

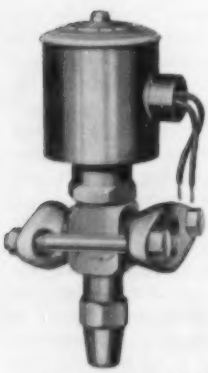
11 PRESSURE CONTROLLER

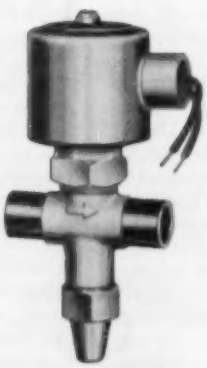


12 WATER-REGULATING VALVE

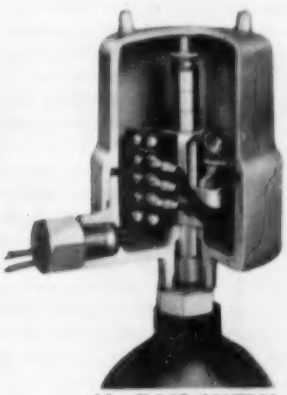


13 EVAPORATOR PRESSURE REGULATOR

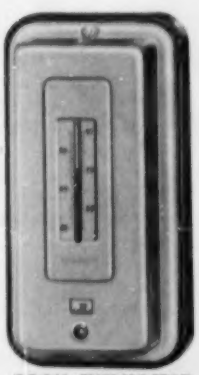




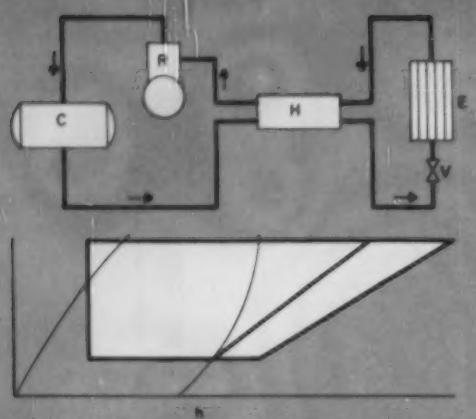
14 SOLENOID VALVES: AMMONIA AND FREON



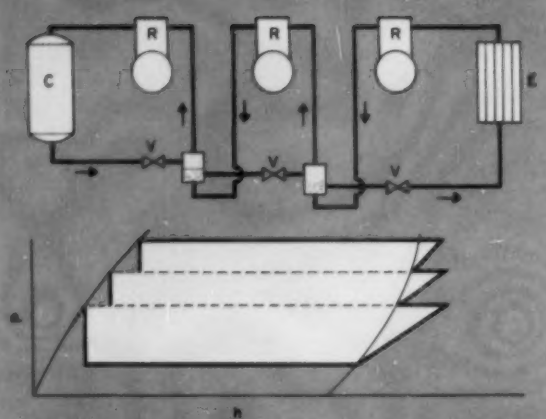
15 FLOAT CONTROL



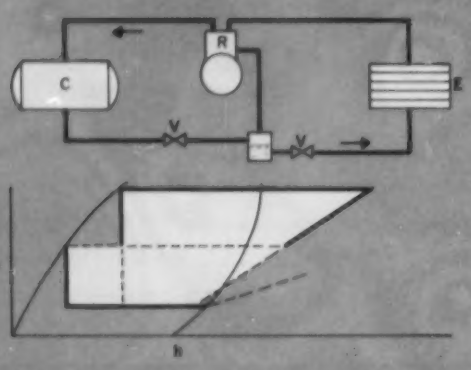
16 ROOM THERMOSTAT



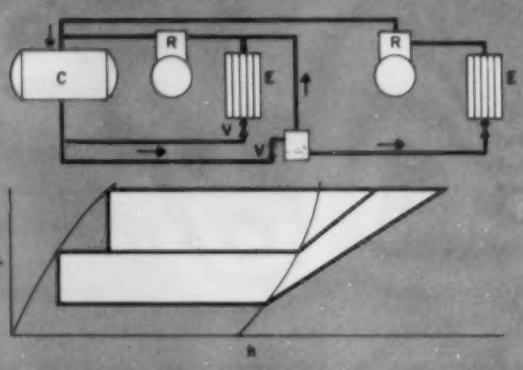
SUBCOOLING the liquid refrigerant is a simple way to secure greater refrigerating effect. The suction gas is often used



COMPOUND COMPRESSION uses two or more stages between evaporator, condenser; requires less power input for operation



DUAL OR MULTIPLE-EFFECT compression has one compressor to handle suction gas at two different pressures; is economical



SECTIONALIZING is way of operating two or more evaporators at different pressures and temperatures without too much loss

C = *condenser* E = *evaporator* H = *heat exchanger* R = *refrigeration compressor* V = *expansion or control valve*

Refrigeration applications

End purpose of every refrigeration system is production of a lower temperature by transfer of heat from a place where it is not wanted to a place it is unobjectionable. And many different schemes are used to improve efficiency.

Subcooling of the refrigerant liquid on way to the expansion valve can be produced by use of either water, or suction gas leaving the evaporator. The liquid is subcooled when its temperature is less than that corresponding to its pressure.

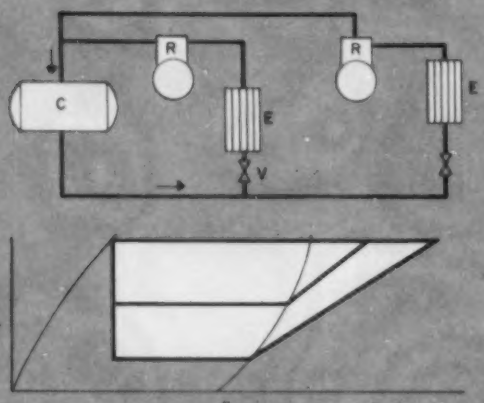
Advantages of subcooling include (1) reduction of some of the flash loss in the expansion valve, (2) an increase in refrigerating effect obtained in the system. Also compressor and condenser loads are reduced and superheating of the suction gas between the evaporator and compressor is prevented or minimized. Though subcooling by water is possible, use of suction gas is more common.

Compounding consists of using two or more stages of compression between the evaporator and condenser. Usually two separate compressors are used, one high-pressure and one low-pressure unit, but other arrangements are possible. Less power input is needed in compound systems than in the single-stage systems operating over the same temperature and pressure range.

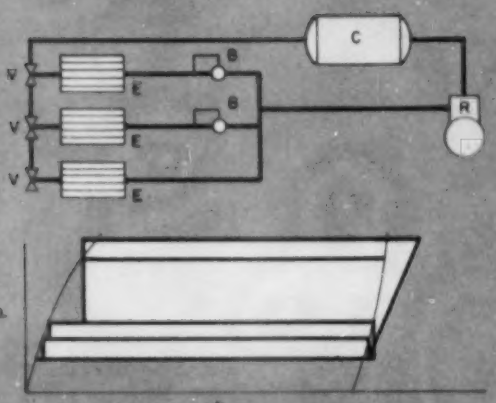
Though power saving is the principal advantage of compounding, the possibility of cooling liquid refrigerant with gas going to the high-pressure compressor suction and cooling the low-pressure discharge gas in a water-cooled intercooler offers further economies. Compounding is widely applied to low-temperature systems using reciprocating compressors. In these jobs the low-pressure unit is often called a booster compressor. It handles large volumes of low-pressure refrigerant gas leaving the evaporator.

Dual or multiple-effect compressors handle suction gas at two different pressures in the same cylinder. Lower-pressure gas is drawn in during the normal suction stroke. It is compressed and near the end of the stroke the piston uncovers a port through which the higher pressure gas is admitted. The piston completes its stroke, compressing all gas in the cylinder and discharging to the condenser.

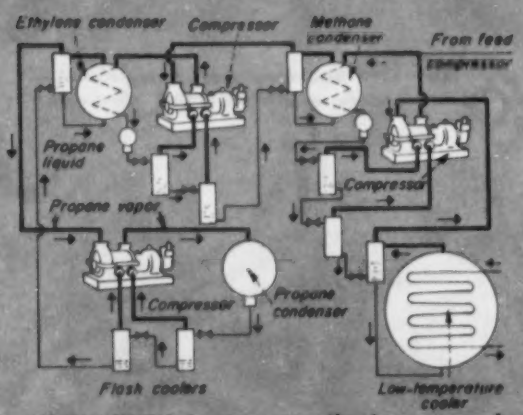
Multiple-effect compression is not the same as compounding because there is no chance for intercooling, together with the attendant savings. Instead, multiple-effect compression is like having two separate compressors, each operating at a different suction pressure but discharging to a single



PARALLEL OPERATION is another way of hooking up two or more evaporators for different suction pressures and temperatures



MULTIPLE EXPANSION VALVES, backpressure valves can give close control of two or more different-pressure evaporators



CASCADE SYSTEM shown uses centrifugal compressors for ultra-low temperatures in liquefied-gas storage, has high efficiency

Theoretical compressor power for a Freon-12 plant*

Loads: 10 tons at 44 F, 30 tons at 34 F, and 20 tons at 24 F

Type of system	Hp	Reduction from maximum, %
One compressor:		
All evaporators at same temperature	53.6	0.0
Individual exp valves and backpressure valves	52.4	2.2
Multiple exp valves and backpressure valves	51.7	3.5
Two compressors (one dual-effect type):		
Individual expansion valves	47.7	11.0
Multiple expansion valves	45.9	14.4
Three individual compressors:		
Individual expansion valves	46.4	13.4
Multiple expansion valves	44.7	16.6
Compound compressors and intercoolers:		
Individual expansion valves	46.0	14.2
Multiple expansion valves	44.5	17.0

*From "Refrigeration and Air Conditioning," by Jordan and Priester, Prentice-Hall, Inc

condenser. Some designs of dual-effect compressors have clearance pockets to provide capacity control.

The principal advantage of multiple-effect compression is a reduction in system power costs. Many ice plants use it for this purpose. It also is a convenient means of operating two evaporators at different temperatures.

Sectionalizing is one method of operating two or more evaporators at different pressures and temperatures without the necessity of compressing the gas from higher-pressure evaporators through a range greater than required. As shown in the equipment diagram above, two compressors may be used, one for the low-pressure evaporator and one for the high-pressure evaporator. Both discharge to a common condenser. Flash vapor formed in the low-pressure expansion valve is separated in a flash chamber, from where it flows to the suction of the high-pressure evaporator.

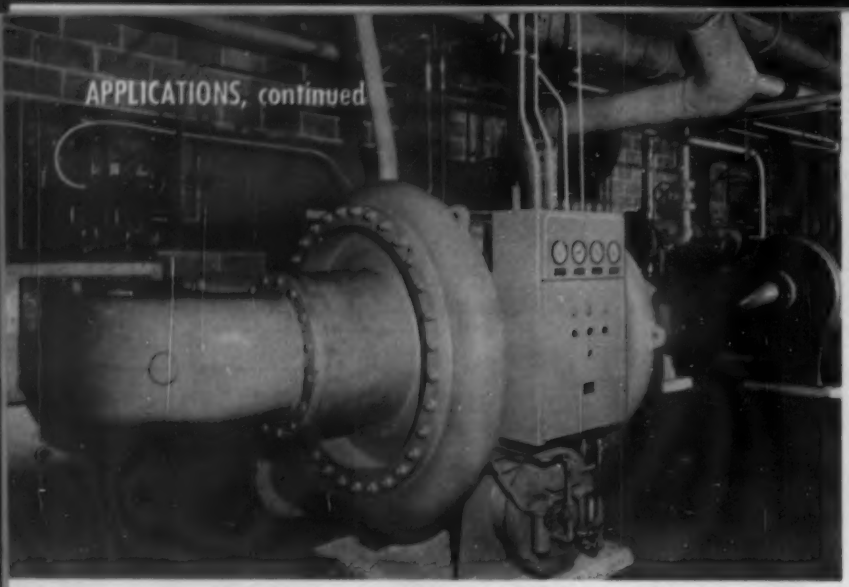
Parallel operation is another method of providing for two or more evaporators using different suction pressures and temperatures. As shown, each evaporator has its own expansion valve and compressor, but there is a common condenser. The compressors and their evaporators operate independently except for using the common condenser. Either dry-type evaporators, p 82, or flooded-type, may be adopted. In latter not all the refrigerant evaporates, the vapor-liquid mixture flowing to a surge drum from which vapor is drawn off by the compressor and liquid is recirculated to the evaporator.

Multiple-expansion valves in conjunction with backpressure valves are another means of providing for two or more evaporators at different pressures and temperatures. With this hookup the evaporators shown have a common suction pressure, corresponding to that of the lowest-temperature evaporator. The backpressure valves in the two higher-temperature evaporators maintain the higher coil pressures required in them. Table, *above right*, shows the power input savings possible with a fixed load and various hookups.

System size is a definite factor in the arrangement chosen. Large systems, where power savings may be considerable, often use one or more of the arrangements shown. Others, not shown here, are also used, depending on the specific requirements of the process served by the system.

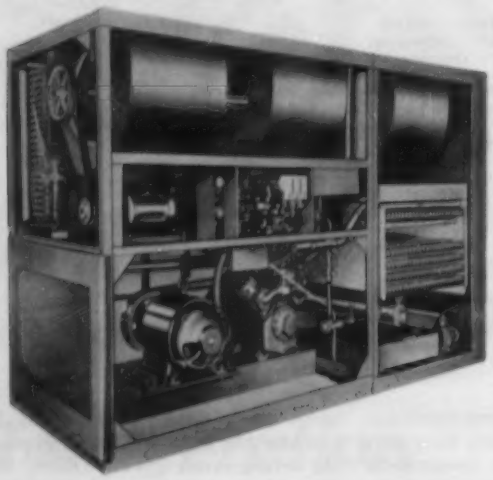
In small systems the power savings possible may be insignificant because the power input required is small to start with. So one or more special controls are used instead of a multiple-compressor hookup. Typical controls include thermostatic expansion valves, backpressure valves, float switches, suction-pressure regulators, etc.

Extremely low temperatures may be produced in a number of ways. One popular method, called the cascade system, uses a series of refrigerants having progressively lower boiling points. As shown above, one refrigerant serves as the coolant to condense the refrigerant gas with the next lower boiling temperature. Cascading is generally applied at temperatures below about −135 F, but with newer refrigerants becoming available it is possible that this temperature might be lowered in the near future.

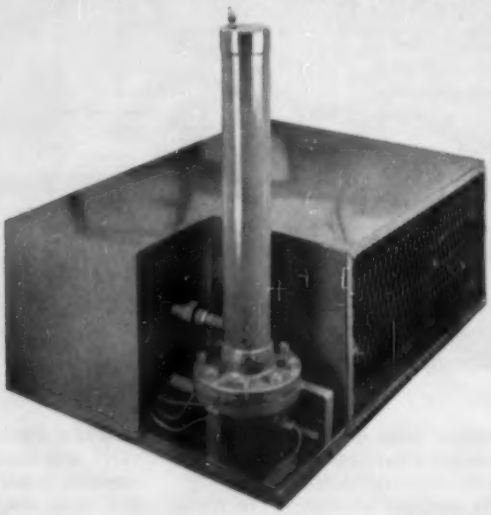


AIR-CONDITIONING installations use centrifugal compressors for the larger loads. A wide range of sizes permits multiple installation to give the desired capacity

RECIPROCATING compressors here serve an air-conditioning system in a hospital



UNIT AIR CONDITIONER contains Freon-12 compressor, condenser, evaporator controls. Fans blow conditioned air to rooms



SOLVENT COOLER for dry-cleaning plants uses a hermetically sealed compressor, is fitted with solvent circulating pump

Without going too far off the beam we can classify refrigeration applications in seven broad categories—air conditioning, food processing and storage, ice making, industrial processes, medical, heat pump and miscellaneous. Illustrations on these two pages show units for a number of these services.

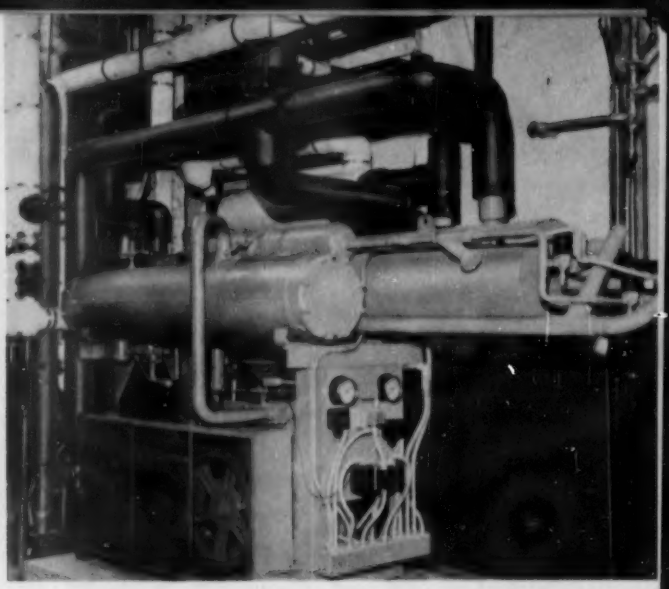
Air conditioning is probably the most talked about application, with the heat pump next. Yet our lives are affected in a great many other ways by refrigeration—someone has even said from the cradle to the grave, and he's probably correct.

From the tiny room air conditioner to the 2000-ton centrifugal serving an entire building, air conditioning uses millions of tons of refrigeration capacity. Unit conditioners available today are compact, noisefree devices requiring a minimum of installation work. Operation, after the unit is turned on, is usually automatic. Though there is no definite capacity limitation on unitary-type equipment, capacities above about 12,000 cfm or about 40 tons of refrigeration are believed to be more economically handled by field-assembled equipment. Multiple installations of unit conditioners are often economical for larger air flows or tonnages where zoning is desired or air ducts must be kept to a minimum.

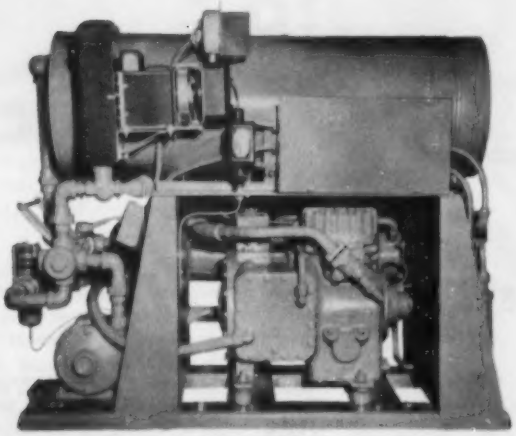
The next step up in capacity from unitary equipment for air conditioning is to the central-type system using field-assembled units serving, usually, more than one room or area, with separate control for each room or area. Ducts generally connect the apparatus with the various rooms, the refrigeration equipment, fans, coils, etc, being in the building basement or another space separate from the conditioned rooms.

As with unit conditioners, there is no definite point at which one type of equipment is used in preference to another. But current practice uses reciprocating compressors and steam-jet units in capacities to about 400 tons, with absorption units running up to

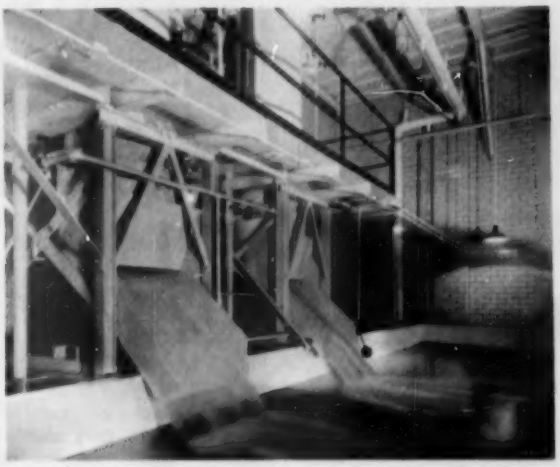
FOOD PROCESSING is another big user of refrigeration. Shown here is an ice-cream storage room fitted with vertical coils



LIQUID CHILLER of packaged design has a dry-expansion type chiller on same base with reciprocating compressor, controls



HEAT PUMPS use refrigeration principles to heat or cool, are finding jobs in some industrial and commercial installations



ICE-MAKING MACHINE is used here in conjunction with storage tank, meets peak loads by cooling makeup water entering tank

somewhat over 700 tons. In systems of over 25 tons capacity we are likely to find reciprocating, absorption, steam-jet or centrifugal, but except for reciprocating units, the representation is rather spotty. Over about 400 tons, centrifugal, absorption and steam-jet units predominate in air conditioning.

Food processing — manufacture, storage and transportation—takes a big chunk of tonnage. While reciprocating compressors are popular in cold storage, frozen foods, packing and manufacturing, other types of units are also used. In a given application the choice of unit type is a function of the load, temperature required, and a number of other important governing factors.

Ice making, one of the earliest applications of mechanical refrigeration, is almost solely in the province of reciprocating compressors. With the widespread use of domestic refrigerators, the emphasis in ice making has shifted somewhat from the can-ice plant to cubed and sized ice. Today, block-ice manufacturers produce about 800,000 tons annually of clear solid cubes, using either automatic or semi-automatic machines. In recent years much study has been given the manufacture of cubes of various sizes and types, resulting in the design of a variety of specialized machines for cube production.

Industrial processes might be called the unknown soldiers of refrigeration because so many products require refrigeration at one stage or another during manufacture or preparation for it. A few of the processes using refrigeration include metal treatment, testing, chemical production, oil refining, rubber manufacture, building construction, natural gas, etc. Temperatures vary over the entire range, requiring many different units.

Medical and surgical applications of refrigeration are growing continually—from blood-plasma manufacture to shock prevention and use as an anesthetic. The Salk vaccine is the latest in a long list of aids to health produced by some use of refrigeration equipment.

Physical properties of common refrigerants

Based on standard-ton conditions: evaporation at 5F, condensation at 86F

Name of refrigerant	Chemical formula	(1)	Critical temp (deg F)	Critical press, psia	Freezing point, F	Boiling point, F	Critical density, lb per cu ft	Critical volume, cu ft per lb	Latent heat of vaporization at boiling point, Btu per lb	Liquid density, lbs per cu ft at 5 F (sat liq)	Vapor density, lbs per cu ft at 5 F (sat vap)	Compressed liquid density, lbs per cu ft at 86 F (sat liq)	lb per ton	Type of compressor (2)	Compressor cooling	Safety group (3)	Safety group (4)	Safety group (5)	Safety group (6)	Concentration in air by volume (%) for flammable or explosive mix, % by volume (7)	Kills or seriously injures when in air: Exposure time, hr	Kills or seriously injures when in air: % by volume concentration	Kills or seriously injures when in air: lb per 1000 cu ft of air	Mix with Ref (8)?	Odor? (9)
Ammonia	NH_3	L–H	−28.0	−107.9	271.2	164.5	19.8	476.6	0.421	19.6	2.46	0.96	Rec	Water	2	150	200	16–25	1/2	0.5	0.25	No	Yes
Carbon dioxide	CO_2	L, H	−109.3	−69.9	87.8	1023.3	116.8	96.5	2.61	107.0	0.96	1.10	Rec	Water	1	1000	1500	.8	1/2–1	20	33	No	No
Dielene	$C_2H_4Cl_2$	H	118.0	−70.0	470.0	16.0*	28.3*	114.3	1.75	98.2	111.2	0.97	Cen	Water	2	50	80	5.6–11.4 D	1	2	5	Yes	Weak
Ethyl chloride	C_2H_5Cl	H, U	54.5	−227.7	369.0	12.4	30.5*	142.9	1.41	44.4	22.62	0.91	Rot.	Air	2	50	90	2.7–12 D	1	4	7	Yes	Yes
Freon-11	CCl_3F	H	76.7	−168.0	388.4	3.6	24.0*	67.5	2.96	96.0	36.3	0.94	Rot. Cen	Water	1	30	50	N, D	2	30	50	Yes	No
Freon-12	CCl_2F_2	H, U	−21.6	−247.0	233.0	99.2	35.6	91.1	3.91	99.9	5.81	1.61	Rec-Rot.	W or A	1	140	225	N, D	2	25	40	Yes	No
Freon-21	$CHCl_2F$	H, U	48.0	−211.0	281.3	34.5	29.3*	80.4	2.29	43.0	20.46	0.93	Rot.	Air	1	40	70	N	1/2	18	27	Yes	No
Freon-22	$CHClF_2$	U, L	−41.4	−256.0	256.0	159.6	29.5	89.3	2.60	96.1	3.68	1.02	Rec	Water	1	150	205	N, D	–	–	–	Yes	No
Freon-113	$C_2Cl_3F_3$	H	117.6	−31.0	417.6	13.9*	27.9*	53.7	2.73	98.4	166.9	0.96	Cen	Water	1	50	80	N, D	1	5	23	Yes	No
Freon-114	$C_2Cl_2F_4$	U, H	38.4	−137.0	294.3	22.0	36.1*	43.1	4.66	95.3	19.36	0.79	Rot.	Air	1	50	90	N, D	1	20	90	Yes	No
Isobutane	$(CH_3)_3CH$	H, U	16.3	−229.8	272.7	44.8	9.2*	111.5	1.79	91.1	11.50	1.06	Rec-Rot.	W or A	3	70	150	1.8–8.4	–	–	–	Yes	Weak
Methyl chloride	CH_3Cl	H, U	−10.8	−144.0	289.8	80.8	6.5	190.2	1.38	60.9	5.96	1.02	Rec-Rot.	W or A	2	120	210	8.1–17.2 D	2	2	3.5	Yes	Weak
Methylene chloride	CH_2Cl_2	H	103.0	−142.0	421.0	6.4*	27.4*	134.6	1.49	30.9	74.3	0.97	Cen	Water	1	30	50	N, D	1/2	5	11	Yes	Weak
Sulfur dioxide	SO_2	H, U	14.0	−103.9	314.0	51.8	5.9*	142.6	1.40	28.6	9.30	0.97	Rec-Rot.	W or A	2	85	170	N	5 min	0.7	1.2	No	Yes
Water (40 F & 86 F)	H_2O	H	212.0	32.0	706.1	29.7*	29.7*	1025.3	0.105	5.4	476.6	1.13	Cen-Jet	Water	–	–	–	N	–	–	–	No	No

(1) B–Nitrogen, H–Hydrogen, C–Carbon, Cl–Chlorine, F–Fluorine, S–Sulfur
(2) U–Ultra-low: −120 to −70 F, L–Low: −70 to 0 F, M–Medium: 0 to 30 F, H–High: over 30 F, (3)* Inches of mercury vacuum, (4) Rec–Reciprocating, Cen–Centrifugal, Rot.–Rotary, (5) ASRE Std 15-52; L–Used generally with minor limitations, R–Used generally with minor limitations, S–Permitted in all but industrial occupancies and commercial laboratories in unit systems containing not over 5 lb; see Standard for exact limitations for all refrigerants.
(6) From ASA-E, Std 15-52; (7) N–nonflammable, except slightly flammable Freon-21; D–Decomposition products from most of these are highly toxic.
(8) Decomposition products of Freons, etc, have pungent odors.

Refrigerants and brines

There is no perfect refrigerant, nor is there one refrigerant which is usable for the complete cooling range required in industrial and commercial applications. So we find a large number of refrigerants in use today.

Properties. Table above summarizes properties of many common refrigerants. Note that so-called safety factors — toxicity, irritant properties, flammability etc, play important parts in refrigerant choice, especially where large numbers of people might be exposed to the gas during system failure. With ever-widening use of air conditioning, we find older refrigerants like ammonia, carbon dioxide and sulfur dioxide decreasing in use for smaller units. They have been replaced by members of the Freon family—refrigerants made from hydrocarbons.

Physical properties of refrigerants are also important because they too affect selection. Boiling and freezing points and critical temperatures set rough limits on the kinds of jobs for which refrigerants are suited. "Heat" or enthalpy properties, tables, *facing page*, determine the amount of refrigerant that must be circulated for a given capacity and are valuable in both system design and analysis.

Using refrigerants that must be condensed at high pressures means heavy construction for the compressor, piping and condenser, increasing system cost.

Some Freons are called *vacuum refrigerants* because they exist as liquid at normal atmospheric temperature and pressure. To produce refrigeration temperatures in an evaporator, these refrigerants must be vaporized at pressures below atmospheric.

Refrigerating-equipment size depends on refrigerant density and the ability of the liquid to absorb heat. These two factors can be combined into one index—piston displacement—which tells how many cubic feet of refrigerant must be handled each minute to produce one ton of refrigeration.

Lubrication of a refrigeration unit depends on compressor design, cooling method, refrigerant used and operating conditions. Table, *right*, gives the viscosity ranges of lubricants commonly used with various types of compressors and refrigerants. Usual aim is to use the oil having the lowest viscosity that gives the required sealing with the refrigerant used at the temperature and pressure ranges met in the system.

Oil properties, which must be considered in practice, include pour test and cloud point, volatility, flash and fire points, moisture, stability and solubility of oil and refrigerant. Pour and cloud points may have little effect in normal air-conditioning applications, but in low-temperature units they may greatly influence lubricant choice. Oil volatility should be chosen so the lubricant does not vaporize at pressures and temperatures met in the high side of the system.

Some refrigerants having high specific-heat ratios have high compression temperatures, leading to carbonization of lubricants with low flash and fire points. To prevent expansion-valve freeze-ups, refrigeration oils should have a low moisture content. Stability against oxidation and heat are also important. Solubility characteristics,

Pressure-enthalpy properties of ammonia and Freon-12

SATURATED AMMONIA

(All values are per lb of refrigerant)

Temp F	Psia	Psig	Liquid density lb/cu ft	Vapor sp vol cu ft/lb	Enthalpy Sat. liquid	Enthalpy Evap	Enthalpy Sat. vapor
-40	10.41	8.7*	43.68	24.86	0.0	597.6	597.6
-30	13.98	1.6*	42.85	18.97	10.7	590.7	[illegible]
-20	18.38	3.6	42.22	14.68	21.4	583.6	[illegible]
-10	23.74	9.0	41.78	11.50	32.1	576.4	[illegible]
0	30.42	15.7	41.54	9.116	42.9	568.9	611.8
5	34.27	19.6	41.11	8.150	48.3	564.8	613.3
10	38.51	23.8	40.88	7.304	53.8	561.1	614.9
20	48.21	33.5	40.43	5.910	64.7	553.1	617.8
30	59.74	45.0	39.96	4.825	75.7	544.8	620.5
40	73.32	58.6	39.49	3.971	86.8	536.2	623.0
50	88.19	74.5	39.00	3.294	97.9	527.3	625.2
60	107.0	92.9	38.50	2.751	109.2	518.1	627.3
70	128.8	114.1	38.00	2.312	120.5	508.6	629.1
80	153.8	138.3	37.48	1.955	132.0	498.7	630.7
84	169.2	154.5	37.16	1.772	138.9	492.6	631.5
90	180.6	165.9	36.95	1.661	143.5	488.5	632.0
100	211.9	197.2	36.40	1.419	156.2	477.8	633.0
110	247.0	232.3	35.84	1.217	167.0	466.7	633.7
120	286.4	271.7	35.26	1.047	179.0	455.0	634.0

* Inches of mercury below one standard atmosphere (29.92 in.)

SATURATED FREON-12

Temp F	Psia	Psig	Liquid density lb/cu ft	Vapor sp vol cu ft/lb	Enthalpy Sat. liquid	Enthalpy Evap	Enthalpy Sat. vapor
-40	9.317	10.96*	0.93057	3.911	0.00	79.50	79.50
-30	12.02	5.45*	0.9107	3.000	2.00	78.67	80.67
-20	15.20	0.50	0.8908	2.474	4.07	77.80	81.87
-10	19.20	4.50	0.8700	2.000	6.16	76.91	83.07
0	23.87	9.17	0.8490	1.637	8.26	75.96	84.21
5	26.51	11.81	0.8381	1.488	9.32	75.47	84.79
10	29.35	14.65	0.8272	1.351	10.39	74.97	85.36
20	35.75	21.05	0.8053	1.121	12.55	73.94	86.49
30	43.16	28.46	0.7835	0.938	14.76	72.86	87.62
40	51.68	36.98	0.7610	0.792	17.00	71.71	88.71
50	61.39	46.69	0.7378	0.673	19.27	70.51	89.78
60	72.41	57.71	0.7135	0.575	21.57	69.25	90.82
70	84.82	70.12	0.6883	0.493	23.90	67.92	91.82
80	98.76	84.06	0.6625	0.425	26.28	66.52	92.80
86	107.9	93.2	0.6464	0.389	27.72	65.66	93.37
90	114.3	99.6	0.6355	0.368	28.70	65.04	93.74
100	131.6	116.9	0.6077	0.319	31.16	63.46	94.62
110	150.7	136.0	0.5779	0.277	33.65	61.76	95.43
120	171.8	157.1	0.5444	0.244	36.14	59.99	96.15

SUPERHEATED AMMONIA

(V—specific volume; H—enthalpy)

Total temp, F	20 (-16.64) V	20 (-16.64) H	30 (-0.57) V	30 (-0.57) H	40 (11.68) V	40 (11.68) H	140 (74.79) V	140 (74.79) H	170 (86.29) V	170 (86.29) H	200 (96.34) V	200 (96.34) H
-10	13.76	610.0	–	–	–	–	–	–	–	–	–	–
0	14.09	615.5	9.250	611.9	–	–	–	–	–	–	–	–
20	14.78	626.4	9.731	623.5	7.203	620.4	–	–	–	–	–	–
40	15.45	637.0	10.20	634.6	7.568	632.1	–	–	–	–	–	–
60	16.12	647.5	10.65	645.5	7.922	643.4	–	–	–	–	–	–
80	16.78	658.0	11.10	656.2	8.266	654.4	2.166	633.0	–	–	–	–
100	17.43	668.5	11.55	666.9	8.609	665.3	2.284	647.0	1.837	641.9	1.520	635.6
150	19.05	694.7	12.65	693.5	9.444	692.3	2.569	679.9	2.081	675.9	1.740	671.0
200	20.66	721.2	13.73	720.3	10.27	719.4	2.839	708.9	2.303	706.9	1.935	703.9
250	–	–	14.81	747.5	11.08	746.8	3.090	739.2	2.516	738.0	2.110	734.5

SUPERHEATED FREON-12

Total temp, F	20 (-0.2) V	20 (-0.2) H	40 (23.9) V	40 (23.9) H	60 (43.7) V	60 (43.7) H	120 (93.9) V	120 (93.9) H	140 (104.5) V	140 (104.5) H	160 (114.8) V	160 (114.8) H
20	2.060	81.16	–	–	–	–	–	–	–	–	–	–
30	2.107	82.50	1.039	81.76	–	–	–	–	–	–	–	–
40	2.156	83.87	1.064	83.20	–	–	–	–	–	–	–	–
60	2.205	86.60	1.090	84.98	0.680	83.83	–	–	–	–	–	–
80	2.250	88.85	1.095	86.11	0.706	86.53	–	–	–	–	–	–
100	2.343	89.70	1.144	89.09	0.743	88.35	–	–	–	–	–	–
120	2.437	92.75	1.194	92.09	0.778	91.41	0.357	89.15	–	–	–	–
130	2.530	95.78	1.242	95.15	0.812	94.51	0.377	92.39	0.314	91.89	0.264	90.60
140	2.623	98.85	1.291	98.26	0.846	97.65	0.397	95.65	0.332	94.64	0.282	94.12
160	2.716	101.97	1.340	101.42	0.880	100.84	0.417	98.96	0.350	98.34	0.298	97.87

having important influence on lubricant performance, are best evaluated by tests in the actual unit.

Brines. There are many refrigeration applications where direct-expansion evaporators, p 82, cannot be used, while there are others in which it is impossible to locate the evaporator in the area or substance to be cooled or frozen. Also, chilled water cannot be used below about 33 F. To serve such jobs brines are commonly used in *indirect* systems.

The usual hookup of an indirect system consists of a brine cooler, a brine pump and distributing piping. Cooler, usually of shell-and-tube design, acts as the evaporator for the refrigerant. Cold brine is circulated by the pump to the areas requiring cooling. Where compressor operating periods must be limited, hold-over or congealing tanks may be used for brine storage.

Commonly used brines are water solutions of calcium, sodium or magnesium chloride. Brine freezing point depends on solution strength, as tables, *right*, show. Calcium-chloride and sodium-chloride brines are the most widely used, with calcium chloride suitable for lower temperatures. Other brines include some of the glycols, alcohol and glycerin.

Suggested lubricant viscosity ranges

	Recommended viscosity ranges, sus at 100 F
SMALL SYSTEMS (Rec-Reciprocating compressor, Rot-Rotary, Cen-Centrifugal)	
Rec: Carbon dioxide, methyl chloride, Freon-12, 21; Rot. Freon-114, sulfur dioxide; Cen: methylene chloride, Freon-11, 12, 113	200-300
Rec: Ammonia; Rot: methylene chloride	150-300
Sulfur dioxide (Rec)	70-200
INDUSTRIAL REFRIGERATION (ammonia and carbon-dioxide compressors)	
Where oil may enter refrigeration system or compressor cylinders	150-300
Where oil is prevented from entering system or cylinders: (1) in force-feed or gravity systems	500-600
(2) in splash systems	150-165
Steam-driven compressor cylinders when condensate is reclaimed for ice making	140-165 at 210 F
MISCELLANEOUS EQUIPMENT	
Bearings: (1) ring oiled, normal temperature	200-300
(2) ring oiled, low temperature	100-115
(3) chain oiled	200-300
Ball and roller bearings, oil lubricated	200-600
Wick oilers	200-600

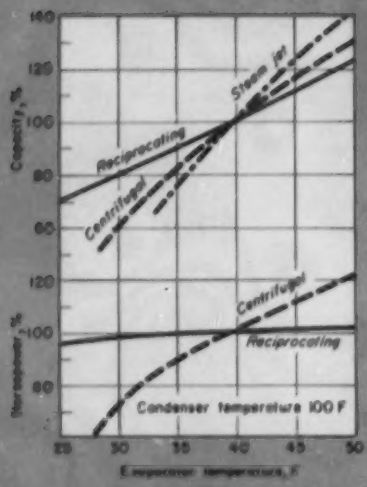
Physical properties of brines

Sodium chloride

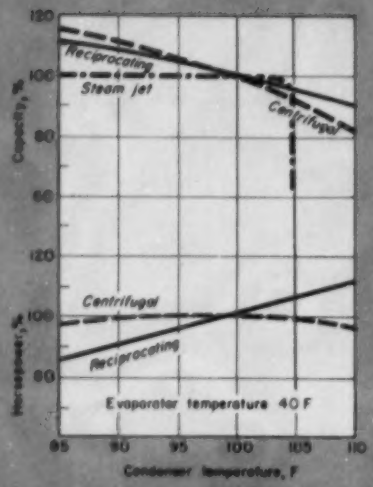
% pure NaCl by weight	Specific gravity at 59 F	Specific heat at 60 F	Freezing point, F	Wt, lb per gal NaCl	Wt, lb per gal Water
0	1.000	1.000	32.0	0.000	8.35
5	1.035	0.930	27.0	0.432	8.22
10	1.072	0.860	20.4	0.895	8.05
15	1.111	0.847	12.0	1.392	7.80
20	1.150	0.813	1.0	1.920	7.60
25	1.191	0.705	16.1	2.488	7.46

Calcium chloride

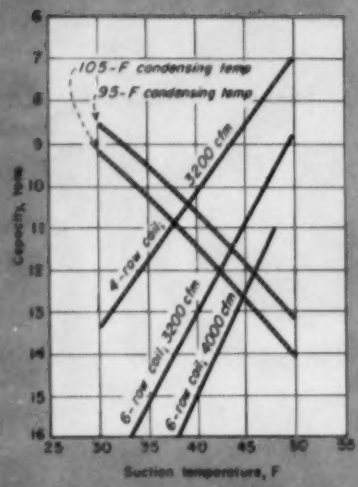
% pure $CaCl_2$ by weight	Specific gravity at 59 F	Specific heat at 60 F	Freezing point, F	Wt, lb per gal $CaCl_2$	Wt, lb per gal Water
0	1.000	1.0000	32.0	0.000	8.350
5	1.044	0.9265	29.0	0.436	8.331
10	1.087	0.8564	23.0	0.908	8.164
15	1.133	0.7900	12.5	1.416	8.034
20	1.182	0.7275	- 3.0	1.970	7.883
25	1.233	0.6690	-25.0	2.574	7.721



EVAPORATOR temperature and its effects on performance of various compressors*



CONDENSER temperature and its effects on performance of various compressors*



SYSTEM BALANCE can be studied on plot like this for compressor, evaporator

Refrigeration equipment for air-conditioning

Data from ASHAE "Guide," Chap. 37, 1955

Capacity, tons	Majority used	Some used	Few used
0 to 5	Unit systems in conditioned space	Unit central systems, duct distribution	Built-up central systems
5 to 25	Built-up central systems, reciprocating compressors	Unit central systems, duct distribution	Unit systems in conditioned space Built-up systems, absorption and absorption systems
25 to 50	Built-up central systems, reciprocating compressors	Built-up central systems, centrifugal compressors	Central systems, absorption systems
50 to 400	Built-up central systems, reciprocating compressors	Built-up central systems, steam-jet and centrifugal compressors	
400 and over	Built-up central systems, centrifugal compressors	Built-up central systems, steam jet	

Compressor efficiency*

Compression ratio	Volumetric efficiency, %	Performance factor, hp per ton
2.0	88.50	0.72
2.2	87.00	0.81
2.4	85.60	0.89
2.6	84.20	0.96
2.8	82.90	1.05
3.0	81.60	1.13
3.2	80.03	1.20
3.4	79.10	1.27
3.6	78.00	1.34
3.8	76.70	1.41
4.0	75.60	1.47
4.2	74.50	1.54
4.4	73.50	1.60
4.6	72.50	1.67
4.8	71.40	1.73
5.0	70.04	1.78
5.2	68.90	1.84
5.4	68.40	1.90
5.6	67.40	1.96
5.8	66.40	2.02
6.0	65.30	2.07
6.2	64.30	2.13
6.4	63.40	2.18
6.6	62.50	2.24

*Approximate values for high-speed Freon units

Equipment selection and use

Correct sizing of refrigeration equipment for a given load is extremely important—undersizing can lead to damage of expensive products or personnel discomfort, while oversizing may cause uneconomical operation. The aim of correct choice is a balanced system giving economical operation for all normal loads, with sufficient reserve for expected overloads.

First step in equipment selection is determination of heat loads expected. Heat may be gained from any one or all of four sources—the room or area refrigerated, the air in the room, stored products and miscellaneous sources.

Heat gain from the room results from transmission through the walls, ceiling and floor. Amount of heat gained depends on type of wall and floor construction, type and thickness of insulation, area insulated, and temperature difference between the inside and outside of the room.

Air enters a refrigerated space every time a door is opened. To maintain the desired temperature level within refrigerated room, temperature of the entering air must be reduced. This imposes a definite load on the equipment.

Products placed in the refrigerated area generally must have their temperature reduced, and in many instances must be frozen, requiring removal of additional energy in the form of heat, p 76. Amount of heat that must be re-

Freon reciprocating compressor rating table

Suction Temp, F	Suction Gage pressure, psi	Condensing temperature and pressure: 85 F, 91.7 psi gage — Tons	85 F — BHP	95 F, 108.1 psi gage — Tons	95 F — BHP	105 F, 126.2 psi gage — Tons	105 F — BHP	115 F, 146.3 psi gage — Tons	115 F — BHP
−10	4.5	3.4	6.6	3.1	6.7	2.7	6.7	2.4	6.5
−5	6.7	4.0	7.0	3.6	7.2	3.2	7.2	2.9	7.1
0	9.2	4.6	7.5	4.2	7.7	3.8	7.8	3.4	7.8
5	11.8	5.3	7.8	4.9	8.1	4.4	8.3	4.0	8.3
10	14.7	6.1	8.1	5.6	8.5	5.1	8.8	4.6	8.9
15	17.7	6.9	8.5	6.3	8.9	5.8	9.2	5.3	9.4
20	21.1	7.8	8.7	7.2	9.2	6.6	9.6	6.1	9.9
25	24.6	8.8	9.0	8.1	9.5	7.5	10.0	6.9	10.4
30	28.5	9.8	9.1	9.2	9.8	8.5	10.4	7.8	10.8
35	32.6	11.0	9.2	10.2	10.0	9.5	10.7	8.8	11.2
40	37.0	12.3	9.2	11.4	10.2	10.7	11.1	9.8	11.6
45	41.7	13.6	9.1	12.7	10.2	11.9	11.2	11.0	11.9

Rating table for absorption refrigeration machines

	Internal-coil machines											Open machines										
Nominal capacity, tons (45-F chilled water, 85-F condensing water, 12-psig steam)	103	137	182	232	260	308	334	424	485	585	681	109	145	193	245	275	317	353	448	512	619	731
Nominal steam rate, lb per hr per ton	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0
Solution	1½	1½	2	5	5	5	5	7½	7½	7½	7½	1½	1½	2	5	5	5	5	7½	7½	7½	7½
Pump horsepowers—Evaporator	3	3	3	3	3	3	3	5	5	5	5	–	–	–	–	–	–	–	–	–	–	–
Purge	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4	4	4	4
Condensing water, gpm	400	525	700	850	945	1100	1225	1560	1750	2150	2460	400	525	700	850	945	1100	1225	1560	1750	2150	2460
Condensing-water pressure drop (total), psi	14	19	12	13	15	14	16	15	18	10	14	14	19	12	13	15	14	16	15	18	10	14
Absorber passes	4	3	2	3	3	2	2	3	3	2	2	4	3	2	3	3	2	2	3	3	2	2
Chilled water, gpm	–	–	–	–	–	–	–	–	–	–	–	275	360	480	610	685	790	875	1110	1270	1530	1820
Condensate (max. startup) lb per hr; for steam trap selection only	7,500	10,200	13,800	17,100	19,500	22,200	25,200	31,200	36,300	43,800	54,000	7,500	10,200	13,800	17,100	19,500	22,200	25,200	31,200	36,300	43,800	54,000

Typical rating chart for centrifugal compressors

Pass arrangement and gpm range	Leaving chilled-water temp, F	Leaving condenser-water temperature: 80 F A	80 F B	80 F C	85 F A	85 F B	85 F C	90 F A	90 F B	90 F C	95 F A	95 F B	95 F C	100 F A	100 F B	100 F C
	40			178.7			174.4			169.2			160.1*			147.6*
4-pass evaporator	42			182.0			178.3			173.5			167.8			156.8*
143-670 gpm	44		192.6	185.3		188.4	181.5		183.3	177.2			171.8			165.5
velocity, fps = gpm × .021	46		196.3			192.1			187.2	180.0		181.0	175.2			169.3
4-pass condenser	48	206.6	200.0		200.9	195.7		190.5*	191.2			186.3	177.8		178.3	172.3
120-604 gpm	50	212.2			207.7			202.5	194.9		195.0	189.6			183.2	
velocity, fps = gpm × .025	52	216.6			212.3			207.4			201.0	193.0		192.9	186.5	
	40			177.5			173.1			168.0			156.4*			
4-pass evaporator	42			181.1			177.3			172.0			166.0			152.2*
143-670 gpm	44		191.7	184.2		187.1	180.2		181.6	175.8		167.5*	170.3			163.9
velocity, fps = gpm × .021	46		195.2			190.7			186.7			178.7	173.9			167.8
3-pass condenser	48	208.7	198.6		196.5*	194.4			189.7			183.8	176.5		176.1	170.8
158-529 gpm	50	210.7			204.5				193.5		189.0*	187.7			181.3	173.0
velocity, fps = gpm × .019	52	215.5			210.8			206.8			198.5	191.4			184.7	

Boldface numbers indicate rated capacities, tons; italicized numbers are for reference or interpolation. Capacities based on 165 bhp using Freon-113. A, B and C indicate different impeller combinations.
*These ratings require less than 165 bhp

Tonnage capacity of Freon piping

Compressor discharge lines — Length of pipe, ft	Pressure drop, psi	Outside diameter of pipe, in.: 5/8	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8	3 1/8	3 5/8	4 1/8	5 1/8	6 1/8
		Inside diameter of pipe, in.: 0.545	0.785	1.025	1.265	1.505	1.985	2.465	2.945	3.425	3.905	4.875	5.845
	1	0.6	1.6	3.2	5.7	9.1	19.0	34.1	55	82	117	213	347
	2	0.9	2.3	4.8	8.4	13.4	28.2	50.5	82	122	173	315	512
50	3	1.1	2.9	6.0	10.5	16.8	35.4	63.2	102	153	216	395	643
	4	1.3	3.5	7.1	12.4	19.7	41.6	74.5	120	180	254	465	757
	5	1.4	3.9	8.0	14.1	22.4	47.1	84.4	136	204	291	526	857
Compressor suction lines	1	0.4	1.1	2.2	3.8	6.1	12.8	23.0	37	55	79	144	234
	2	0.6	1.6	3.2	5.7	9.1	19.0	34.1	55	82	117	213	347
50	3	0.8	2.0	4.1	7.1	11.4	24.1	43.0	70	104	148	269	437
	4	0.9	2.4	4.8	8.4	13.5	28.3	50.7	82	122	174	316	515
	5	1.0	2.6	5.4	9.6	15.4	32.3	57.7	94	139	199	360	587
Liquid lines	1	2.8	7.6	15.5	27.3	43.4	91.0	163.2	264	395	562		
	2	4.2	11.1	22.9	40.2	64.1	135.2	241.4	389	583	830		
50	3	5.3	14.0	28.7	50.5	80.5	169.2	302.6	489	733	1042		
	4	6.2	16.5	33.7	59.4	94.4	198.9	356.2	575	861	1225		
	5	7.1	18.7	38.3	67.3	107.1	225.3	403.8	651	976	1389		

Note: Recommended pressure drop at maximum load shown in boldface type

moved is a function of the total weight of product placed in the refrigerated area, its temperature, specific heat, final temperature desired, and the number of Btu that must be given up to produce freezing, if the product is to be frozen. On some jobs this last quantity represents a major portion of the product load.

Miscellaneous heat loads include those from electrical devices within the refrigerated space—lights, motors, etc—people within the space, piping and any other sources. To secure accurate results, these must be carefully evaluated. Note that the four heat sources given above apply equally well to any job.

Second step is choice of compressor type. Table, p 92, shows typical units chosen for air-conditioning jobs. Text, pp 88-89, gives details on the usual types of units chosen for various other classes of jobs—industrial, ice-making, etc. Tables, p 93, show typical rating details that must be reviewed when choosing reciprocating, centrifugal and absorption units. Efficiencies of typical reciprocating units are also shown.

With compressor type and capacity known, the remaining components of the system must be chosen. These include the condenser, evaporator, expansion valve, controls and piping. Earlier pages in this report cover these items.

Piping deserves particular attention during system planning because use of the wrong sizes or types can seriously handicap an otherwise good job. Table, p 93, shows sizes for various tonnages on Freon jobs.

Whenever in doubt about the proper type or size of compressor, component or system to be used, secure the aid of equipment manufacturers and a consulting engineer. Correct choice is too important to be given only passing study.

Equipment use

Factors important in equipment use include head and suction pressures, condenser-water supply, expansion-valve setting, compressor lubrication and load on the machine. While conditions vary from one job to the next, here are some pointers to watch with each compressor type:

Reciprocating. Keep head pressure within recommended limits at all times. Automatic purge units are useful. Excessive head pressure means high side has air and other noncondensable gases trapped in it, increasing the required power input and reducing system capacity. Purge high side to remove air and gas.

Don't pull suction pressure too low—liquid refrigerant may reach compressor suction, where it can do damage. Watch suction-line frost; it's a fair indicator of whether the pressure is right. Keep an eye on your compressor gages and controls at all times—they show up troubles in the making.

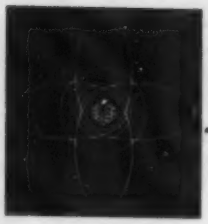
Get advice before making final choice of compressor lubricating oil. The right oil goes a long way toward making compressor operation more dependable, and can aid in increasing system operating economy. So don't guess; it doesn't pay.

Centrifugal. Usually fitted with built-in purge units, head pressure in these machines is less likely to give trouble than with reciprocating compressors. On most jobs it is common practice to run the purge unit before the main machine is started to insure ridding the machine of noncondensables.

Surging in many centrifugals is normal, and there's nothing to worry about except at low loads. At 10 to 20% of full load, surging can cause compressor to overheat, raising bearing temperature. So don't operate continuously under these conditions without getting advice from the manufacturer.

Absorption, steam-jet. With both these types, steam supply is extremely important because without it no refrigerating effect can be produced. So be sure you always have enough steam at pressure the unit requires.

POWER wishes to thank the many refrigeration-equipment manufacturers who offered advice and criticism during preparation of this report.



Nuclear notes

Associate Editor

Atomic fuel prices were announced by the AEC for enriched uranium *leased* for research reactors; also included were *sale* prices for normal uranium and heavy water. Uranium enriched to 20% in U-235, for use in research reactors by friendly nations, was priced at $25 per gram of contained U-235. Normal uranium metal will sell for $40 per kilogram (2.2046 lb). Heavy water is for sale at $28 per lb. This means that a pound of 20%-enriched uranium will be leased for $22,700, while a pound of normal uranium will sell for a little more than $18. These prices represent cost of production—no profit or loss being incurred by the AEC.

Enriched uranium fuel fuel containing 20% of U-235 is the maximum being offered for lease to friendly nations by AEC. Enrichment higher than 20% seems to be considered of weapons' grade. A total of 200 kilograms has been set aside for foreign use. About 6¼ kilograms (13.8 lb) will be needed to charge one research reactor.

Elements 99 and 100 were first discovered in the radioactive debris collected from a thermonuclear test performed in the Pacific Ocean in late 1952. This preceded the production of these elements by cyclotron and reactor bombardments that were first reported as the original discovery. Proposed names: for element 99—einsteinium (E); for element 100—fermium (Fm). Element 101 has been named mendelevium (Mv), see POWER July 1955, p 89.

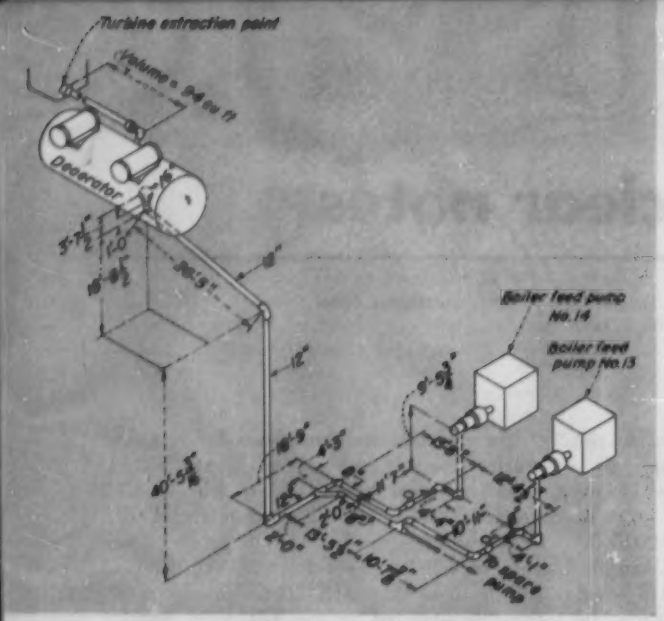
More zirconium and hafnium are needed by AEC for their reactor-development program and Naval projects. They will probably be in the market for 1000 tons of zirconium over a 5-year period, or 600 tons over 3-year period. They will also want as much hafnium as can be produced from this much zirconium processing. At present, AEC has contract with Carborundum Metals Co, Inc, of Akron, N. Y., for 100 tons of zirconium and 2 tons of hafnium per year. Bids will be invited for additional needs in November 1955—delivery deadline will be about July 1957.

Reactor licensing by AEC is a two-step process. An applicant must first obtain a "construction permit" to build the reactor. After completion of reactor the AEC inspects it and if it meets all safety regulations a license is issued for its operation. If the applicant builds the reactor according to the terms of the construction permit, he should have no trouble meeting license requirements.

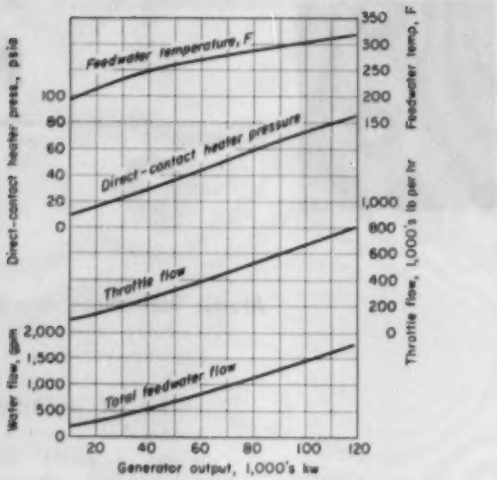
Four separation methods for recovering uranium from used nuclear fuels are being studied by the Argonne National Laboratory. They are: (1) precipitation (2) ion exchange (3) fractional distillation (4) pyrometallurgical or high-temperature process. Dr S Lawroski of the ANL reported encouraging progress with these methods at the Geneva Conference. Cost of the separation process will make or break nuclear fuels as a competitor of fossil fuels.

Preventing aluminum corrosion at high temperatures can be done two ways according to Dr J E Draley and Dr W E Ruther of ANL. (1) Adding ½ to 1% of nickel and iron in aluminum makes an alloy impervious to penetrating corrosion up to at least 660 F. (2) Adding minute amounts of nickel sulfate to water, made acidic with sulfuric acid, protects commercially pure aluminum up to at least 530 F.

Combustion Engineering, Inc has been awarded a contract by AEC to design, build and test a reactor for a small submarine. CE will bear 25% of costs up to $3 million.



1 Suction piping for the boiler feed pumps designed for the 100,000-kw unit. Load characteristics are given in Fig. 2



2 Part-load characteristics of 100,000-kw unit whose feed pumps are shown in Fig. 1

Effect of sudden load drop in open

Centrifugal boiler feed pumps under transient operating conditions may meet severe and complex problems. Here, in the first of a series, are the steps for figuring system design

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► MANY FEEDWATER-CYCLE arrangements are used today. An important basic difference in problems caused by load changes is the feed-pump suction source. Entirely different effects can be expected in open and closed cycles. In this first article we'll consider a system having a direct-contact heater, supplied steam from a bleed stage of the turbine.

Sudden load reduction. When the electrical load drops suddenly, the turbine governor reduces inlet steam flow. There is a proportionate pressure reduction at all stages of the turbine.

In a typical 100,000-kw unit operating at 1450-psi throttle pressure and 1000 F with 1.5-in.-Hg backpressure, a load reduction from 100,085 to 49,910 kw is accompanied by a fall in throttle flow from 665,810 to 324,910 lb per hr. Pressure at heater bleed point falls from 78.6 to 39.2 psia, while at the heater it falls from 73.1 to 36.5 psia. Table 1 and Fig. 2 show part-load performance of unit.

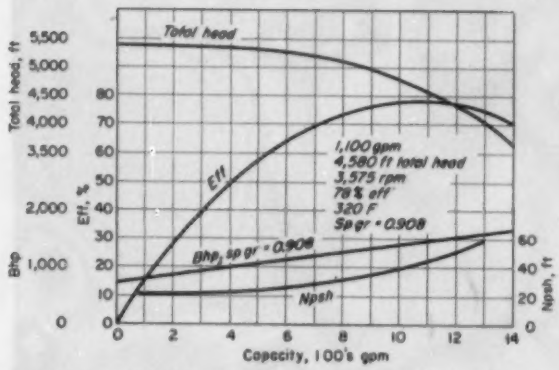
Extraction line to heater has a check or nonreturn valve. Since the heater is a reservoir of hot water, its pressure cannot be reduced as rapidly as the turbine extraction stage when load is suddenly reduced. Valve closes, isolating heater from turbine until heater pressure falls to that of the extraction point.

Net positive suction head (npsh) available for pump may be seriously reduced by the changing relation between decaying heater pressure and water temperature at pump suction. Magnitude and duration of this reduction varies with load drop and depends on a number of factors peculiar to each installation.

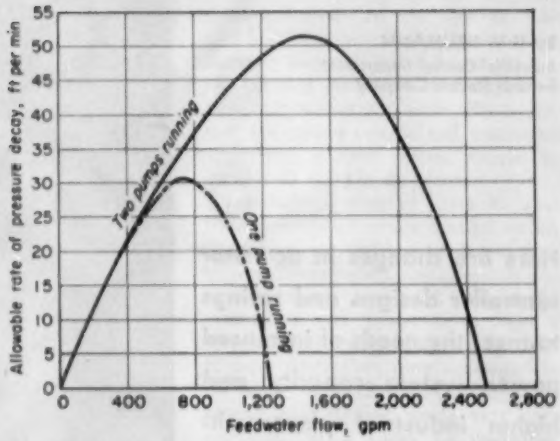
Insufficient npsh. Some value of positive head above the vapor pressure of the entering fluid is required at pump suction. Such a value provides the energy necessary to maintain flow and compensate for entrance losses, preventing impeller cavitation. It is reduction of available npsh below this value, with the possibility of cavitation, that is of concern during a load drop.

Cavitation in a multistage pump limits its capacity and induces severe vibration. Beginning when available npsh falls below required npsh, cavitation may not occur simultaneously and uniformly over the entire inlet area of the first-stage impeller. The amount and direction of the radial thrust developed undergoes rapid and violent fluctuations. Resulting vibration could cause contact at the running joints, leading to galling and seizure of the rotating element. No feed pump can withstand an unlimited amount of flashing and vibration.

Allowable rate of pressure decay in the direct-contact heater to insure minimum required npsh must be compared to the actual rate of decay accompanying the load drop. For a fixed pump flow, the allowable rate of decay in the heater is controlled only by the difference in elevation between the heater and pump center line, internal volume



3 Performance characteristics of the boiler feed pumps for the 100,000-kw unit whose part-load performance is given



4 Allowable rate of pressure decay in the direct-contact heater serving the 100,000-kw unit analyzed in article

feed cycles

of connecting piping, friction loss in this piping and npsh required by pump.

Under fluctuating conditions during the period corresponding to the residence time in the suction piping, heater pressure must not fall more than the amount by which the static-head-less-friction losses exceed the pump required npsh. The last column of Table 2 gives the mathematical expression for this relation. In using this expression the entire flow coming down the suction pipe should be considered as dq/dt. Balancing-device leakoff, if returned to the heater, should be added to the boiler flow to obtain the total flow.

When more than one pump is running and the suction piping to the pumps is not absolutely symmetrical, calculations for the residence time must be made by adding the sum of the time in the common pipe to that of the time in the suction piping of the pump under study. For the common pipe the time is based on the total flow to all pumps, while for the other pipe it is based on flow to only one pump.

Typical computation. Consider a group of pumps installed to serve the unit whose performance is given in Table 1. Fig. 1 shows the suction piping for these pumps. Static head is 58.6 ft and friction losses 4.5 ft at a total flow of 2600 gpm to the boiler with two pumps operating. Other pertinent data

(*Continued on page* 218)

1: Part-load characteristics of a 100,000-kw unit installation

Kw generator output	Throttle steam flow, lb per hr	Pressure at heater extraction point, psia	Direct contact heater pressure, psia	Feedwater flow, lb per hr	Feedwater temperature F	Spec grav	Feedwater flow, GPM	
							Total	Per pump
118,860	798,500	94.1	85.7	809,510	318.3	0.910	1778	889
100,085	656,000	78.6	73.1	668,810	305.8	0.916	1452	726
49,910	314,000	39.2	36.5	324,910	261.7	0.938	694	694 (1) 347 (2)
9,850	85,000	10.5	9.8	93,210	192.2	0.968	192	192 (1) 96 (2)

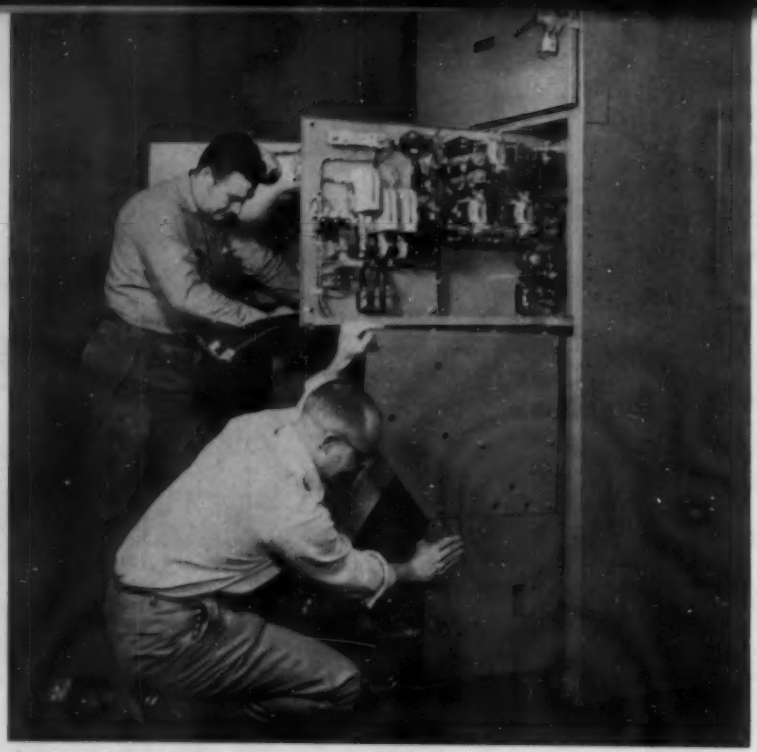
(1) One pump running (2) Two pumps running

2: Allowable rate of pressure decay

Pumps running	Feedwater flow $\frac{dQ}{dt}$ in GPM		Residence time, Δt in minutes	Required npsh, Hs in feet	Available npsh, Ha in feet	Excess npsh, Hx in feet	Allowable rate of pressure decay $\frac{dP}{dt} = \frac{Hx}{\Delta t}$, ft per min
	Total	Per pump					
2	0	0	Infinity	20.5	58.6	38.1	0
2	300	150	2.257	21	58.6	37.6	16.7
2	600	300	1.231	22	58.4	36.4	29.6
2	1000	500	0.766	24.5	57.9	33.4	43.6
2	1400	700	0.536	28	57.3	29.3	52.7
2	1600	800	0.489	32	56.9	24.9	50.9
2	2200	1100	0.359	46	55.4	9.4	26.2
2	2400	1200	0.329	51	54.8	3.8	11.6
2	2600	1300	0.305	60	54.1	None	None
1	0	0	Infinity	20.5	58.6	38.1	0
1	200	200	3.070	21.3	58.5	37.2	12.1
1	400	400	1.642	24	58.3	34.3	20.9
1	600	600	1.120	26	57.9	31.9	28.5
1	800	800	0.850	32	57.4	25.4	29.9
1	1000	1000	0.685	40	56.8	16.7	24.4
1	1200	1200	0.574	51	55.9	4.9	8.4

By G W HEUMANN
Industrial Control Department
General Electric Company

Here are changes in ac-motor controller designs and ratings to meet the needs of increased power-system capacity and higher industrial-plant voltages. They will help you select this equipment correctly for a given application



1 Current-limiting fused starter used for the co-ordinated control of squirrel-cage, synchronous, wound-rotor and multispeed high-voltage types of ac motors

How to select today's high-voltage

► STARTERS AND CONTROLLERS for high-voltage ac motors—601 to 5000 v—are generally considered as control, rather than switchgear. NEMA Standards for Industrial Control govern their design. High-voltage-motor branch circuits between controller and motor represents an extension of the power-distribution system. Faults on a motor's branch circuits are hazards to this system, hence power-system engineers are interested in performance specifications of high-voltage controllers connected to their lines.

NEMA Standards for high-voltage controllers are based on the premise that faults on branch circuits cannot be avoided by economical means. Therefore, select high-voltage motor controllers that have adequate interrupting capacity to clear faults on branch circuits without endangering the power system.

Class E controllers. Before industrial power lines were interconnected with large metropolitan utility systems, it was common to use Class A controllers, with interrupting ability of ten times rated motor current. These can handle motor overloads up to stalled-rotor currents, but are not adequate for short-circuit currents. Protection against short circuits was left to feeder breakers, which were usually oil type having an interrupting time of about eight cycles.

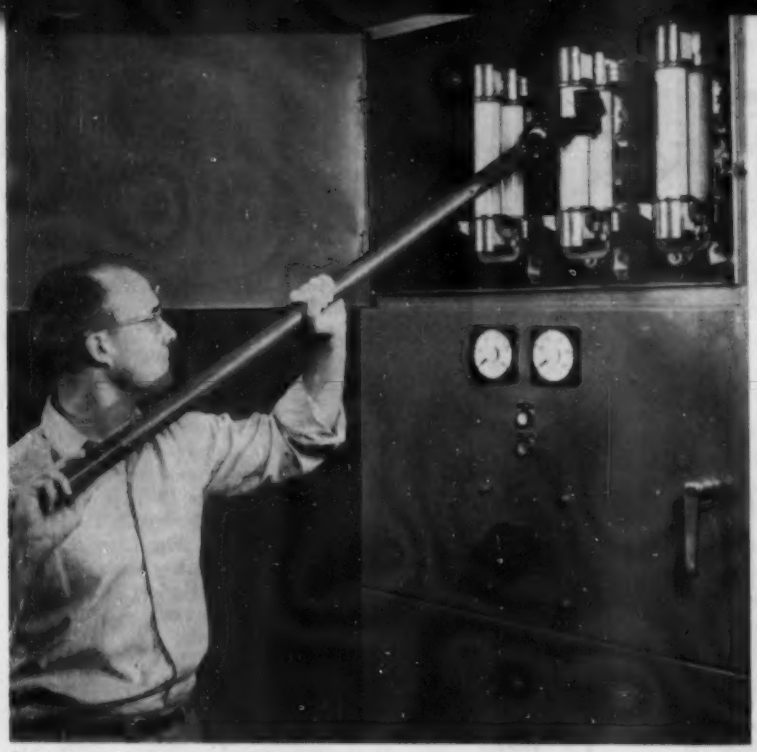
This controller-breaker combination does not give adequate short-circuit protection for motor branch circuits connected to modern industrial power systems. NEMA has abandoned Class A designation for high-voltage controllers, but it still exists for low-voltage designs. This means NEMA no longer recognizes as standard high-voltage controllers having an interrupting ability of ten times rated motor current. NEMA has adopted a Class E designation for high-voltage controllers with a stated high interrupting ability, considered standard for use on high-voltage-motor branch circuits.

Short-circuit current. Two classes of controllers are in general use, E1 and E2. Class E1 uses controller main contacts for interrupting motor load, overload and short-circuit current. Components handling the main power circuit may be circuit breakers or contactors, either air break or oil immersed. These breakers or contactors must have an interrupting capacity adequate for the motor branch-circuit short-circuit fault current.

Class E2 controllers use controller main contacts for interrupting load and overload currents, and fuses for short circuits. Power switching components are frequently manually operated switches or contactors. These need have only an interrupting rating of ten times motor rated current. Fuses may be the so-called power type that clear the fault in about one cycle. Also used are current-limiting fuses, which melt before the short-circuit current reaches its crest value within its first half cycle. These fuses must have adequate interrupting capacity, and controller design has to be such that the fault is cleared by the fuses and not by the controller contacts.

Controller selection. Fig. 3 shows how motor controllers fit into a power system. Short-circuit current that flows into the fault is determined by power-system impedance from the source to the fault, and what other motors connected to the system contribute.

Short circuits on a branch circuit may occur at any point between controller load and motor terminals, or even inside the motor. Impedance be-



2 Fast-acting high-voltage fuses clear short circuits in less than one-half cycle before they have time to harm controller contactors, the motor or the cable

ac-motor controllers

tween controller and motor has a current-limiting effect. Highest short-circuit current flows when a bolted short exists at the controller's load terminals. While such a fault is not likely to occur during normal operation, it may be closely approached when equipment is started for the first time. Tools may be dropped or left so as to bridge the load terminals. Or phases may be tied together because of a mistake in connections, easily made when reversing and on part-winding controllers. Hence, it is assumed that the controller must be capable of interrupting a bolted fault with zero impedance at its load terminals.

Magnitude of controller impedance, which is difficult and costly to determine, varies with the geometry of current-carrying parts. It is also affected by motor-rating, size of overload relay coils and heaters, current transformers and other parts. To eliminate this uncertainty and make it easier for users to select controllers from published handbook data, it is accepted practice of control manufacturers to disregard controller impedance. They rate, list and apply Class E controllers on basis of short-circuit current, which could occur at line terminals of controller.

In line with traditional high-voltage switchgear practice, Class E controller rating is expressed as short-circuit kva. These are the product of available rms short-circuit current, rms line-to-line open-circuit voltage, and a 1.73 phase factor for a 3-phase controller. This leaves the question: What current do you use for determining the short-circuit kva?

Symmetrical vs total current. Short-circuit current per phase, as calculated from voltage and impedance from source to fault, plus motor contribution, is a symmetrical current, which would flow ultimately if the short circuit were not cleared. However, the total current that may flow initially is the sum of the symmetrical short-circuit current and a transient dc current. The latter decays from a crest value varying between zero and a symmetrical peak, depending upon where on the voltage wave the short circuit occurred. The dc component time constant depends on L/R ratio of the impedance to fault.

Value of interrupted current in one phase, expressed as an rms current, equals square root of the sum of the square of the symmetrical value and square of the dc component at the instant the circuit opens. The dc component depends on interrupting time and becomes zero, if this time is long enough. For reduced duty on the circuit-opening device it is desirable to have long interrupting time. But to protect the power system and connected apparatus, a short circuit should be cleared as quickly as possible.

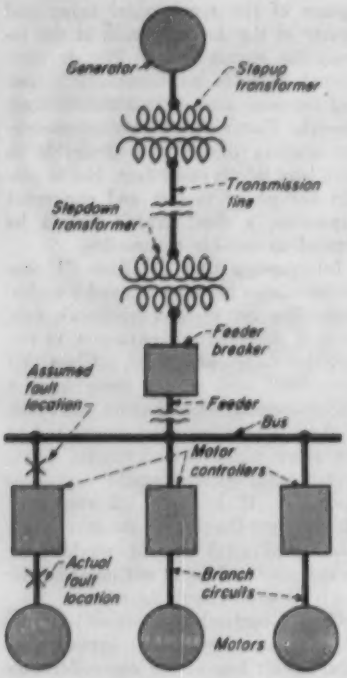
Interrupting time of Class E1 controllers varies between 1½ and 8 cycles, depending on whether air-break contactors, oil-immersed contactors, or circuit breakers are used. Class E2 controllers with power fuses have a circuit-opening time of about one cycle. If these controllers were connected to the same motor branch-circuit, interrupted total current would vary considerably. If a Class E2 controller with current-limiting fuses were used, interrupted total current would have no meaning and could not describe the available short-circuit current.

Class E controllers are rated in terms of maximum available symmetrical short-circuit kva at the controller line terminals. This procedure simplifies listing controllers, and their application by users, since all controllers suitable for a given branch circuit have the same rating. Any differences in the actual interrupting duty, in terms of total kva, do not concern the user. They are taken into account by control manufacturers in design of controller parts. Also, it is necessary to use a specific test procedure. This verifies symmetrical kva interrupting rating while subjecting the controller to a total kva representative of the duty to which it may be subjected where installed.

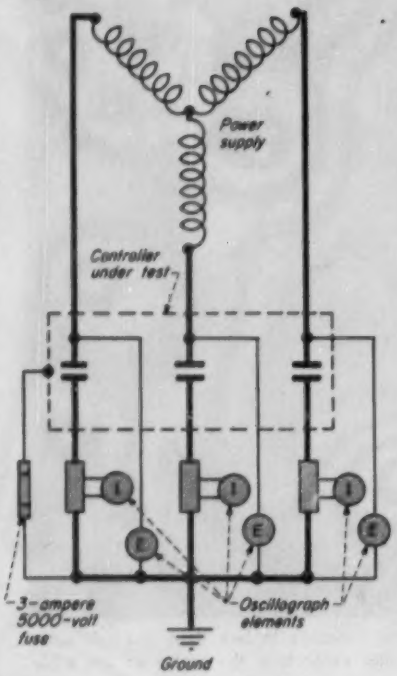
Testing setup. According to NEMA standards for Class E controllers, the test circuit Fig. 4 is used. Since controller rating is based on available short-circuit current, the test circuit is first calibrated without the controller in circuit. With the controller short-circuited at its line terminals, the test circuit must be capable of producing an rms symmetrical current not less than the controller's short-circuit kva rating. During a 3-phase test the symmetrical current is taken as an average in the three phases.

Interrupting duty that a controller actually performs depends on total current flowing at instant of current interruption. On a 3-phase test, currents in the three phases will contain dc components of different magnitude because the 3-phase voltages are displaced by angles of 120 electrical degrees.

An AIEE Working Group on Methods of Rating Power Circuit Breakers has made an extensive study of the problem



3 Diagram of power system with branch circuits between controller, motor



4 Test circuits for Class E controllers that comply with NEMA standards

of how to specify the current with which interrupting tests are to be made. Results of this study are published in AIEE Technical Paper 54-134, "A New Basis for Rating Power Circuit Breakers." NEMA standard for Class E controllers follows the same procedure as recommended in this report. It is specified that the test circuit must produce in one of the three phases a total rms current (including the dc component) which, at various times after initiation of the short circuit, bears a ratio to the rms symmetrical current as given in the table, below.

Further requirements of the test circuit are: (1) Power factor of the circuit should not exceed 0.15 lagging, to insure high rate of rise of recovery voltage when current is interrupted at zero. (2) Open-circuit line-to-line voltage should not be less than that on which interrupting rating is based.

Test-circuit calibration. With test circuit, impedance adjusted so test currents can be obtained according to the table, and with a bolted short circuit applied to the controller's line terminals, the test system is ready for the calibration shots. Power factor of the test circuit and the ratio between subsynchronous and synchronous impedance determine total rms current during the initial cycles, hence compliance with the table.

Calibration shots may be initiated by a synchronous switch, so adjusted that maximum offset is obtained in one phase. If synchronous switching equipment is not available at test station, several random shots may be taken to obtain one with maximum offset in one phase.

During calibration test, one line-to-line voltage is read, while test source is open-circuited. Current flowing after closing of circuit is measured by oscillograph in all three phases. Determine total rms current from the oscillograms according to the American Standard C37.5-1953.

When adjusting the test circuit, set excitation of test generator and total impedance to obtain the 1.6 ratio for the initial half-cycle (see table). Choose a L/R ratio for the external impedance, to reduce the dc component practically to zero after four cycles, so as not to impose too severe a duty on controller during interrupting tests.

Interrupting tests. After calibrating the test circuit remove the short circuit from the controller's line terminals and short-circuit its load terminals. The test cycle consists of three close-open (CO) operations, in which the opening follows immediately after the closing. On Class E1 controllers, the CO operations follow each other at 2-minute intervals. For Class E2 controllers the interval between CO operations has to be long enough to change fuses, inspect contacts and, if necessary, replace them.

Class E2 controllers are tested with highest current fuses for which the controller is designed. Use random switching for initiating the test shots. Synchronous switching is not permissible. Random switching represents the interrupting duty to which a controller may be subjected when in service.

During interrupting tests, current through the controller and line-to-neutral voltage across it are measured by oscillograph elements for each phase, Fig. 4. Oscillograms show if current interruption has been successful. Also, line-to-line voltage across two phases is measured to show that recovery voltage is not less than controller-rated voltage.

After an interrupting test the controller should show no mechanical damage, except blowing of fuses. It must withstand in its open position, rated voltage without dielectric breakdown. It has to carry rated current at rated voltage for a limited time, even though permissible temperature rises of some of its parts may be exceeded. It need not perform another interrupting test without some overhauling and minor repairs, such as replacement of contacts. On Class E2 controllers, contact tips may blow open during an interrupting test, and may weld.

During an interrupting test, slight "spits" of flame may go over to the frame or the controller enclosure. Experience shows that such ground currents of short duration are not harmful to interrupting performance, as long as they do not initiate arcs that permit a substantial ground current to flow. For this reason the controller frame during test is grounded through a 3-amp 5000-v fuse, as in Fig. 4. If this fuse blows during a test, controller's performance is considered unsuccessful. Likewise, an interrupting test is a failure if flame or oil is thrown out of the enclosure.

Short current required by NEMA in testing Class E controllers

Time after initiation of short circuit, cycles (60-cycle basis)	Ratio of rms total current to rms symmetrical current
½	1.6
1	1.4
2	1.2
3	1.1
4 or more	1.0

Con Edison completes F-R turbine lube test

- **Fluid passes test as fire-resistant lubricant**
- **Foaming proved to be a critical problem**

Past nine months have been a period of watching and waiting for utility men weighing the feasibility of adopting a synthetic fire-resistant fluid as lubricant in steam turbine-generators (POWER, March 1955, p 75; August 1955, p 97). Interest has been centering about the impending report from Con Edison in N.Y. on their operating experience with a chlorinated phosphate-ester fluid, Socony Mobil's RL 265-A, installed as a lubricant in a turbine-driven boiler feed pump at Waterside Station.

First details were released September 23 by W C Beattie, manager of Con Edison's Production Department, in a talk before Production Committee of the Southeastern Electric Exchange, Charlotte, N. C.

Beattie pointed out that prior to turbine testing, fire-resistant qualities of the chlorinated phosphate-ester fluid were carefully tested in Con Edison labs. Three important properties were noted: (1) Fluid will not ignite when spilled on a steel pipe heated to 1250 F, but forms a grayish-white vapor. (2) Fluid burns at 1150 F when trapped between steel pipe and magnesia block insulation. (3) Fluid burns when in contact with oxyacetylene flame, snuffs out immediately when flame is removed.

► THE FOLLOWING is a record of findings by Consolidated Edison, with comments by A C Stutson of Socony Mobil.

September 19, 1954. The RL 265-A phosphate-ester fluid replaced regular turbine oil in No. 81 boiler-feed-pump turbine at Waterside Station. GE turbine is rated 1537 hp at 4650-rpm with 200-psi 500-F steam at throttle. Turbine drives a Byron-Jackson feed pump having a 470,000-lb-per-hr capacity at an 1800-psi discharge pressure. Lube systems in both turbine and pump are independent of each other. System holds about 65 gallons. Two Andale bronze oil coolers with internal bypasses, and two metallic cylindrical filter-screens, cool and filter oil delivered to bearings and governor circuit. Bearing oil pressure is 15 psi, governor's is 60 psi.

Before adding the F-R fluid, turbine oil system was cleaned in three successive steps. First it was flushed with Bendix cleaner, an alkaline material. This was followed by two batches of clean turbine oil. After each flushing, oil lines were blown back from bearings and oil reservoir thoroughly swabbed. Final step was to fill reservoir with the chlorinated phosphate-ester fluid.

Clarification setup was installed since this particular turbine had a record of water leaking into the lubrication system from turbine glands. Fluid-conditioning equipment consisted of a DeLaval centrifuge with a skimmer-type bowl (since fluid's density is greater than that of water) and a Honan-Crane filter with Navy-type inert cartridges. A 30-mesh stainless-steel screen was placed in the reservoir, just above fluid level, to spread fluid discharging from return lines, hence reduce turbulence. Because of possible toxicity of fluid fumes, reservoir was vented to atmosphere through a 4-ft pipe discharging above the pump and away from personnel.

After but a few hours' operation, fluid started foaming and a white vapor appeared at point where return oil discharged from journal and thrust bearings at governor end of turbine. Bearings started to heat, requiring pump be shut down. Inspection showed two bearings wiped and oil passages to those bearings plugged with softened paint. Foaming was caused by air entrainment on suction side of Honan-Crane purifier. Bearings were reconditioned and pump returned to service on October 4, 1954 with a new batch of the same RL 265-A chlorinated phosphate-ester fluid.

October 7, 1954. More foaming. New gaskets were installed on two flanged joints of main oil-pump suction as a possible remedy. Also, a 4-in. square box of 30-mesh stainless steel was installed over bearing-oil regulator return line to reduce turbulence. During this early period, the DeLaval centrifuge and the Honan-Crane filter were operated up to eight hours at a spell. Considering the small amounts of water removed, this 8-hour stint was too long. So on October 25th, the separator was run only one hour each watch. Foaming continued.

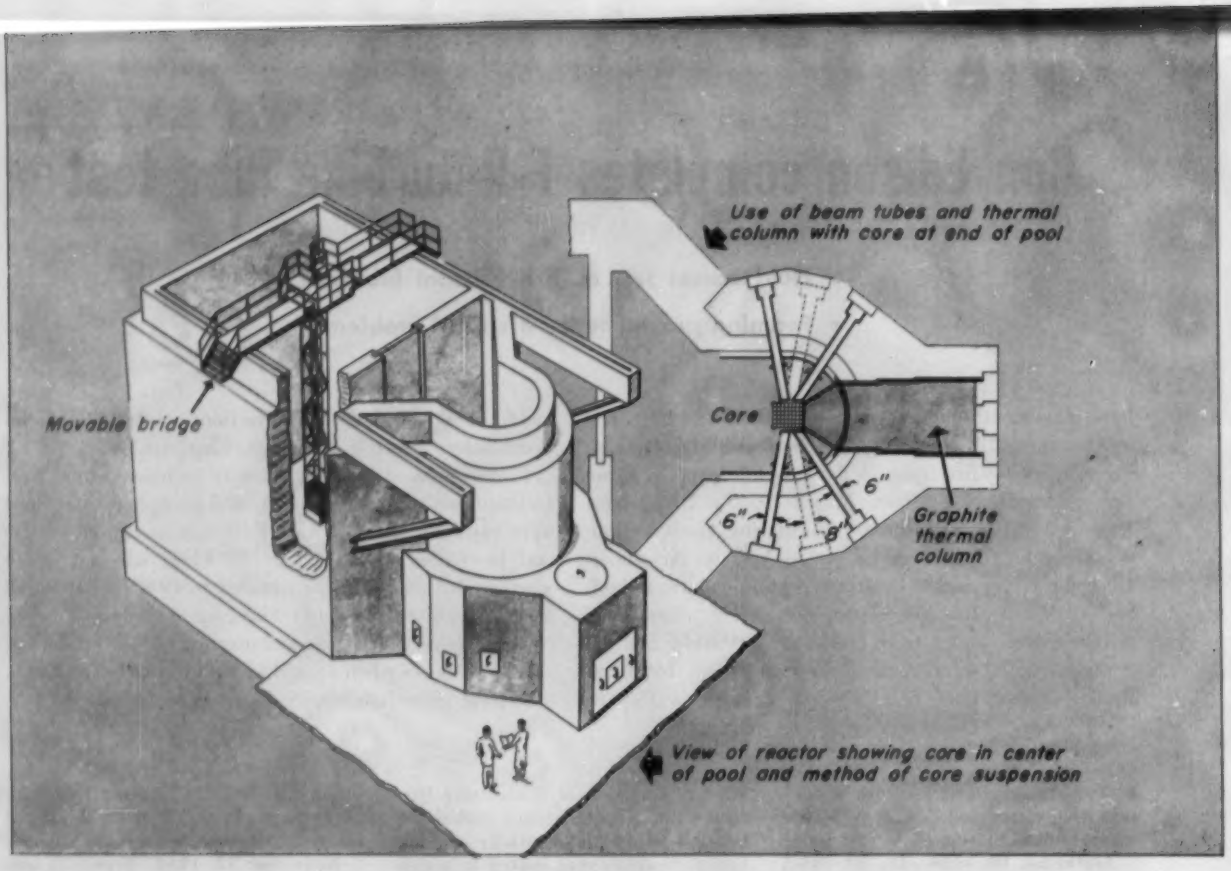
To pin down whether centrifuge was inducing foam, its use was discontinued. So from November 4 to 24, 1954, the DeLaval separator was out of service. During this time 2 to 3 in. of water accumulated at the lubricant reservoir's bottom on several occasions.

November 30, 1954. Separator was raised from operating floor to a platform 4 ft higher, allowing gravity return from separator to reservoir. Honan-Crane filter was removed shortly after. Reason? It was found ineffective for removing water (which it was never designed to do) plus developing many leaks that stimulated further foaming. Even with these changes, fluid continued to foam. When foam thickness was excessive, pump was generally shut down to allow foam to settle out.

February 28, 1955. Fluid temperature at cooler outlet was raised from a normal 120 to 150 F. Aim here was to help water removal. However, fluid foaming continued. Next step was installing an additional 30-mesh stainless-steel screen at a 45-deg angle under return line in reservoir. Purpose of this addition was to increase fluid aeration. This last change seemed effective, at least temporarily. On March 20th, fluid foaming started again, but this time an air leak was found in the governor return line.

April 12, 1955. After 3667 hours of service, heavy foaming was noticed and the pump shut down. After an 8-hour settling period, the pump was restarted, but foaming persisted. From then on, Beattie in his talk detailed each problem met and the steps taken. At one point a fresh 60-gal charge of RL 265-A was introduced. Later on, Dow-Corning 200 foam inhibitor was added, but without permanent results.

(*Continued on page* 230)


Use of beam tubes and thermal column with core at end of pool
Movable bridge
Core
6"
6"
6"
Graphite thermal column
View of reactor showing core in center of pool and method of core suspension

Battelle's swimming-pool type reactor, together with

Nuclear-research laboratory waging

► REACTOR investment and fuel-processing costs need extensive research and development to make nuclear plants competitive with conventional steam plants. To this type of work, Battelle Memorial Institute's new nuclear-research laboratory will apply its facilities. Located near Columbus, Ohio, this nuclear lab is the first in the U.S. to be built with private capital.

The Atomic Energy Commission is studying reactors in its 5-year program. These include widely differing types, such as the pressurized-water reactor at Shippingport, Pa., and the homogeneous reactor at Oak Ridge. None stands out yet as the most economical.

The "zero power" or critical assembly of fissionable materials is an important experimental method in designing power reactors. Critical-assembly laboratories similar to Battelle's, p 104, exist at (1) Oak Ridge (2) Westinghouse Atomic Power Division, Bettis Field, Pa. (3) Argonne National Laboratory, and at (4) GE Knolls Atomic Power Laboratory.

Battelle's research reactor, above, ready in February 1956, will serve in a variety of ways in developing power reactors. It will send neutrons through the "thermal column" into an "exponential assembly"—a subcritical array of fissionable material, moderator, coolant, etc, simulating a power reactor. This is an important tool in finding the best way to put a power reactor together.

The research reactor will help measure radiation effects on materials and supplement the materials-development laboratory in discovering and forming new materials.

Low fuel burn-up proves a principal stumbling block to economical atomic power. Only a few percent of the atoms can be fissioned now before the physical changes make it necessary to reprocess the fuel elements. Because the fission products are highly radioactive the reprocessing must be done in remotely controlled chemical plants.

After reducing the fissioned fuel elements to a chemical solution and separating out the radioactive fission products, the fissionable material must be passed back through all the steps of making it into a metal and fabricating it into the proper shape. Any development that produces higher burn-ups or lower reprocessing and refabrication costs will pay huge dividends in economical atomic power.

New uranium alloys, compounds and cermets are being studied as fuel structures to stand higher burn-ups. New methods are being sought to reduce fabrication costs and chemical reprocessing. Small samples of fuel materials are fissioned to different degrees of burn-up to study the physical changes produced in the metal or cermet structures. The irradiated samples must be examined in special remote-handling laboratories called "hot cells," top of page 103.

Battelle's fuel-element and metals-working laboratories will, as they have since the early days of the Manhattan Project, prepare the alloys in fuel structures for test. These metallurgical

remote-handling hot cells for radioactive materials, forms...

battle for economical atomic power

and ceramic facilities are as important as the test reactor or the hot cell in developing better fuels.

The radioisotope laboratory and the gamma-irradiation facility apply less directly in power-reactor development, but they are essential adjuncts to research in this field.

RESEARCH REACTOR

The swimming-pool type reactor is very similar to the Bulk Shielding Reactor at Oak Ridge. The core has MTR-type (Materials Testing Reactor) aluminum fuel subassemblies. While the arrangement and number of subassemblies are flexible, the over-all core dimensions will be about 1.5x1.5x2 ft, top of p 102. A movable bridge spanning the pool supports the core. The core operates in either of two positions. Bulk shielding and other large-type experiments will be run in the center of the pool as one position. In the other position at the end of the pool, the reactor stands in front of the beam tubes and the graphite thermal column.

The pool measures about 20 ft wide, 40 ft long and 28 ft deep. The core hangs about 22 ft below water level.

Cooling, shielding, controls, etc, are designed for continuous operation at power up to 1 mw.

Irradiation facilities. The reactor primarily provides neutrons and gamma rays for experimentation. Specimens and experimental setups may be placed at several different locations about the reactor:

1. Two 8-in.-dia and four 6-in.-dia beam tubes extend from the outside vertical walls of the pool through to the face of the core. These tubes are about 9 ft long. Radiation levels at the core face when running at 1 mw will be about:

a. Fast-neutron flux—10^{13} n per sq cm per sec.

b. Thermal-neutron flux — $3x10^{12}$ n per sq cm per sec.

c. Gamma flux—$5x10^{13}$ protons per sq cm per sec.

As a first approximation, these fluxes in the empty tubes decrease as the inverse square of the distance from the core face and are directly proportional to the operating power level.

2. The 4-ft-square horizontal thermal column has 4x4-ft vertical and horizontal entrance surfaces. Thermal-neutron flux at the vertical entrance surface will be about 10^8 n/cm² sec and at the horizontal surface of the thermal column about $5x10^8$ n/cm² sec.

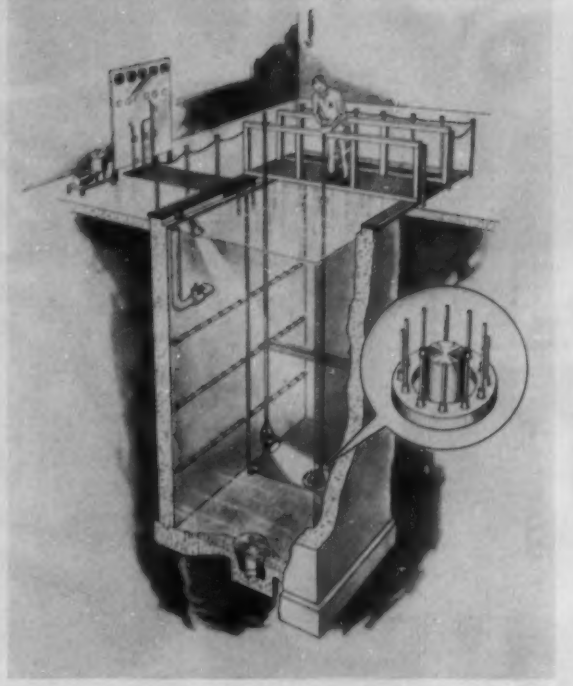
3. Two vertical rabbit tubes pass the face of the reactor core and move with the core structure. Flux levels in the rabbit tubes will be about the same as in the beam tubes.

4. Space in the water around the reactor may be used for specimen irradiation by suspending them from above. The fast-neutron flux attenuates rapidly in the water—by a factor of about 10 per 5 in. from the core. The gamma flux attenuates by a factor of 10 in about 15 in. from the core.

Experimental methods. All the possible experimental applications of the reactor cannot be foreseen or listed.

(*More on next page*)

Critical-assembly lab tests reactor designs



Gamma-irradiation lab uses cobalt-60 source

The reactor design, however, aims to aid the following studies:

1. Radiation damage
2. Activation analysis
3. Isotope production
4. Beneficial radiation effects
5. Neutron diffraction
6. Exponential experiments
7. Shielding experiments

Typical experimental arrangements include the following:

1. *Static irradiation at room temperature and pressure.* This work can be done best by encapsulating the specimens and placing them against the core face. They may be suspended in the water, injected through the rabbit tubes or placed in a beam tube. Factors determining the location include specimen size, duration of exposure, radioactivity level after irradiation, and necessary speed of withdrawal after exposure.

2. *Irradiation of solid specimens at high temperatures in a specified medium.* This will probably be done by designing a special cartridge to fit in a beam tube. Heating, cooling, and containment of the medium will be designed into the cartridge so the specimen can be held under the specified conditions at the end of the cartridge near the reactor face.

3. *Irradiation of fluids in a dynamic system.* For small-scale experiments a special cartridge to fit in a beam tube will be used. The cartridge may contain a heating and cooling system and a circulating loop system for the test fluid. Larger fluid systems will probably be constructed in a coffin and placed in the middle of the pool, with the reactor core moved up to one face of the coffin.

4. *Experiments with neutron or gamma beams.* Special beam plugs will screen out the undesired radiation and lead out a collimated beam of radiation. Experimental apparatus can be set up in reasonably large spaces around the beam-tube ports.

5. *Experiments with the thermal column.* The thermal column provides both a horizontal- and vertical-plane surface source of thermal neutrons. Large experiments may be designed to sit on top of the horizontal surface or to be moved up against the vertical surface. Stringer in thermal column may be moved to provide a small volume source of well-thermalized neutrons.

Experiments with selected irradiations can be made by using appropriate filters between the specimen and the radiation source. For example, a clean gamma flux in a beam tube can be obtained by placing the specimen behind a plug of borated water; or a clean thermal-neutron flux may be obtained by using a thermal column and lead around the specimen.

HOT-CELL FACILITY

This laboratory houses two large hot cells and associated equipment, p 103. High-density concrete in the shells of the hot cells shields the operators. The cells measure 18 ft long, 8 ft wide and 12 ft high. The 3-ft-thick shell of one cell permits safe handling of about 10-million curies of radioactive material emitting gamma rays having an energy of 1 mev (million electron volts). The 2-ft-thick shell of the second cell will be good for about 10,000 curies of gamma radiation.

Each cell has three viewing windows consisting of a 3- or 2-ft thickness of high-density glass. Manipulations in the cells will be made through remote-handling apparatus. Refined operations use master-slave mechanical hands operating through the concrete walls. Each cell has a 1-ton crane. Tools and instruments will be modified for remote operation by mechanical or electrical linkages running through shielded holes in the cell walls.

Two subterranean cells below the main cells are used for storing radioactive solutions and for operations that can be made without direct viewing and manipulation. Holes through the floor of the main cells (normally plugged) permit operating tall equipment higher than the 12-ft clearance of the main cells.

Most equipment in the cells will be mounted on portable tables for flexibility. The major exception will be optical equipment that cannot be moved conveniently. One end of the lower-radiation-level cell contains a permanent

Counting equipment measures radioactivity

Radiochemical lab finds uses for isotopes

installation of remote metallograph and hardness tester. Remote milling machine and lathe will be provided. Other equipment includes mounting press and polishing wheels for remote metallography, periscopes for magnified viewing and for taking photographs, remote analytical balances, remote gages for measuring dimensions, and remotely operated chemical equipment.

Associated hot-cell facilities include a decontamination room for cleaning equipment removed from the hot cells, a large underground storage area for solid radioactive materials, a tank containing water 14 ft deep for storage and handling of radioactive materials, locker rooms, general laboratory space, a machine shop and offices.

The hot cells will be used in two major fields of research: (1) effects of radiation on materials (2) processing of radioactive materials. Before building a reactor the radiation stability of the materials used must be known. The components affected include fuel elements, moderator, coolant, reflector, control rods, instruments and general structural and shielding materials. Irradiated specimens of these components are inspected and measured in these cells for changes in weight, density, dimensions, hardness, strength, and electrical and thermal resistivity. Inspections are made by remote metallography and chemical techniques.

Radioactive - material processing studies include:

1. Reprocessing of nuclear fuels to recover fissionable materials free of fission products and nuclear poisons.

2. Processing of radioactive wastes from fuel reprocessing to a form safe for disposal or industrial use.

3. Processing of radioisotopes into physical or chemical forms for tracer methodology, radiography, radioactive gages, and radiation chemistry or biology.

CRITICAL-ASSEMBLY LAB

This laboratory is used for experimental studies of nuclear-power-reactor cores. A room 40x40x50 ft high houses nuclear-reactor cores mocked up for experimental investigation of various parameters affecting reactor performance, p 104. The mock-up containing all types of material in a finished reactor core will run as a chain-reacting assembly at only 1 or 2 watts. Neither shielding, pressure vessel nor coolant is needed at this low power level. The arrangement of fuel, moderator, control rods, etc, is flexible. It can be changed easily to find the best setup. The mock-up must have the controls and instruments used with a finished reactor.

A control room adjoining the reactor room contains the control console and instruments. A vault below the control room stores the fissionable material. The building also includes instrument laboratories, offices and other facilities.

Because of the flexibility of the critical assembly mock-up, a wealth of important design information may be obtained at relatively low cost. Arrangements and amounts of material in the core can be varied to obtain the optimum design. Core performance can be studied with different control-rod locations. Neutron-flux and heat generation patterns within the core can be studied to avoid intolerable hot spots. Instrumentation and control mechanisms can be evaluated under simulated service conditions.

Studies with this facility prove useful even after a reactor design is frozen. The critical assembly can be used to work out practical start-up schedules. When fuel-element assemblies and control rods have been fabricated for an actual reactor, they may be tested by placing them one at a time in the critical assembly and comparing the performance against a standard element. Critical assemblies can be useful for trying out innovations without interrupting a working reactor.

GAMMA-IRRADIATION LAB

This laboratory facility, p 104, is used for research in radiation chemistry and for sterilizing foods and drugs. Of particular interest are industrial applications for the activation of chemical reactions, such as oxidation, halogenation and polymerization and modifications of properties of plastics and rubber through cross-linking of polymer chains.

This radiation source can also be used to study radiation damage to organic materials used in or around nuclear reactors, such as insulators, rubber, lubricants, etc.

The irradiation facility, occupying an area of 33x25 ft, contains the radiation source and its shield, also associated laboratory and office space.

At present, the radiation source is 2000 curies of cobalt-60. It is housed and used on the bottom of an 8x6-ft tank holding 12 ft of water, p 104. Ma-

(*Continued on page* 220)

HOW TO ORGANIZE YOUR NEW POWER PLANT — 18

Burners, stokers and combustion air affect your boiler's rating

Here's how to get even fuel and air distribution to each burner, and judge adjustment by flame appearance. Also, info on stoker operation and three boiler-draft systems

By D C SWIFT, *Ebasco Services Incorporated*

► BACK IN JANUARY we discussed the different types of burners and stokers, and presented detailed information on lighting and operating each type. Now we get into some further refinements of boiler operation, including information on banking the stokers.

BURNERS

There are many different types of burners, but certain general principles apply to the operation of all. In lighting off, keep air velocity low and air-fuel mixture rich to assure quick ignition without danger of blowing out the lighting torch.

As you start succeeding burners, check those previously lighted to be sure that air- or fuel-supply pressure changes have not put them out. Lighting torches should be of ample size, and placed so fuel stream begins to burn quickly. Use a torch to light off each burner rather than depend on ignition from adjacent burners.

If burner does not light within 20 to 30 seconds, shut off fuel supply and purge furnace for five minutes before attempting to relight.

As soon as burner is lit, adjust air to give complete combustion without using excessive amounts of air. Flame appearance and distance from burner help you judge the adjustment.

Turbulent-type burners should give a short bushy flame, without excessive impingement on furnace walls. Angle of air vanes and amount of air pressure alter the flame shape. Gas, oil or coal burners that are fired from the center can usually be further adjusted by moving admission nozzle in or out. Often a tertiary air supply that changes air-fuel ratio may be used to vary flame length and distance it carries out from the burner.

Type of coal or gas often affects the rapidity of ignition; make changes in burner adjustment to compensate for fuel changes. Changes in rating also affect burner performance. As a rule, you should check adjustment after each major change in rating.

Equal distribution of fuel and air to each burner is important, and may be hard to attain. To get even adjustment of burners, you have to consider: (1) symmetrical arrangement of burner and air-supply piping (2) avoiding excessive air velocities in windboxes (3) use of diffusers in windboxes (4) careful adjustment of pulverizer outputs (5) adjustment of fuel splitters (6) auxiliary and secondary air-vane adjustment. Appearance of burners and a traverse across the boiler with CO_2 or temperature indicator are helpful in assuring adequate air for each burner without using excessive air for other burners.

Oil burners. Oil must be well-atomized and evenly sprayed for good performance with oil burners. Normally you need at least 100 psi to get satisfactory atomization. At low output, you may have to change to smaller sprayer plates, or cut the number of burners in service to get good performance. Keep burner tips clean and free of carbon deposits that would interfere with even spraying of the oil.

Maintain oil temperature at a level to obtain good fluidity without excessive carbon deposit. Blow oil out of burners as soon as they are cut out of service, to assure against carbonizing in the tips.

When making load changes, adjust fuel and air in step with each other so flame is not snuffed out by excessive air flow. It is helpful to have a schedule or chart of fuel pressure vs air pressure. This permits approximating correct air-fuel relation if steam-air flowmeter or combustion control system is out of order.

Coal burners. Slag deposits that form around or over burners are often troublesome and interfere with correct coal-burner operation. Check the adjacent furnace walls and burner rings regularly to see that no obstructions have formed. If coal-air supply from the pulverizers is too hot, you may get deposits in coal nozzles. These will interfere with proper performance. When you take a burner out of service, blow it out with air so there will be no coal deposit left to coke or possibly catch fire.

Idle burners may be subject to over-

heating unless you let a small amount of air pass through them. In some designs a portion of the burner may be retracted to protect it from the heat. There should be some means of assuring that it is returned to proper operating position when it is again placed in service.

STOKERS

Underfeed stokers operate best on a sized double-screened coal that does not have too many fines. The ash should have a rather high fusing temperature to avoid clinkering difficulties. Coal must move down the grate fast enough so fuel is essentially burned out at lower end of stoker.

If you keep fuel bed smooth and fairly heavy, voids do not develop to allow bypassing of combustion air. Air pressure must not be high enough to blow the fuel bed. Remove large clinkers before they impede the downward movement of the burning coal. But don't use hooks or slice bars more often than actually necessary, because stirring the fire tends to develop more clinkers. Remove siftings from below stoker before they interfere with air flow or damper operation.

Adjust stoker sections to get a smooth fire that gradually burns out. Remove ashes before they accumulate enough to impede the movement of ash and coal down the stoker.

Proportion stoker speed to burning rate so fire shape and thickness are always about the same. Arrange coal feed in stoker hoppers so coarse and fine particles do not segregate. Watch hoppers to see that coal feeds steadily into all rams.

You must also constantly watch the fire's appearance. See that no holes or clinkers develop and that it moves down the stoker evenly. On single-retort stokers, adjustments may be made to distribute the fire evenly along the sides of the retort.

In bringing an underfeed stoker down to a banked condition, thin out the fire and burn it down. With less fuel on the grates, boiler will not pop when load is removed. Pressure may also be dropped so there is some leeway for pressure built up until the fire cools. Leave a covering of ashes over the grate to stop air flow. You may start a very light feed after several hours to maintain a cold or hot bank as desired.

To bring a banked boiler back into service, gradually increase the fuel-bed thickness and length before load is to be picked up. Then a good supply of hot coked fuel is available when air flow is increased, and you can increase boiler output rapidly if necessary.

Traveling-grate and chain-grate stokers operate much alike, and will be discussed together.

A gate between coal hopper and grate controls fuel-bed thickness. Speed of grate movement controls the amount of coal fed, and the air supply regulates the amount of fuel burned. This assumes that stoker speed is such as to keep grates covered with coal or ash.

Air for combustion is supplied in a number of separately controlled zones down the length of the stoker. Highest pressure is usually at the front of the stoker and through the brightest part of the fire where fuel is ignited all the way down to the grate. Lower pressures are used as the fire burns thinner. By the time it reaches the rear of the stoker and falls off into the ashpit, fire should be essentially burned out.

Excessive fuel-bed thickness may cause dead spots in the fire, especially if coal is damp or very fine. Too thin a fuel bed may allow blow holes to develop and limit fuel-burning capacity.

Regulate stoker speed in accordance with burning rate to keep the same shape fuel bed at all ordinary ratings. To avoid burning grate metal at lighter loads, hold air pressure under the hottest part of the fire up to one-half the normal pressure.

When boiler is banked, only a thin strip of fire toward the front of the stoker will be burning, the rest of the stoker being covered with ash. As you bring a banked boiler back into service, gradually increase length of fire so more hot fuel is available for meeting steam demands.

You must watch the chains or grate links to see that grate surface remains in good condition. Remove siftings regularly from the air chambers beneath the stoker.

If considerable grate or link burning occurs, peen test thermocouples into several points on the grate surface. Then use temporary couple leads to check temperatures as the grate passes through the fire. You can thus determine and correct errors in firing.

Spreader stokers may throw the fuel out over the grate with a mechanical rotor, or with air or steam jets. The finer particles burn in suspension while the coarser ones fall on the grate and burn. Fuel bed is quite thin, usually less than two inches. Air is fed evenly to all grate surface parts through openings cast into the grates.

Rotor speed or jet-pressure variation provides even grate coverage with the heavier fuel particles not burned in suspension. If grates are the fixed dumping type, coverage should be kept even over the entire grate surface. When several inches of ash have built up, dump the grates one at a time. Dampers are usually provided to cut off air to the section being dumped, and firing and air rate is increased on the other sections to hold up boiler rating.

When traveling grates are used with a spreader-stoker grate, travel and air pressures should be regulated much as with a chain-grate stoker. You want even coverage of the grate surface and complete burn-out of the fuel before it reaches the end of the stoker. Since fuel on the grates is usually quite small, coal feed must be steady and match up well with load and air supply.

It is rather hard to keep a bank on a spreader stoker, but intermittent feed at very low speed may serve to keep a satisfactory fire. Since fire can be started quickly, it is often allowed to die until boiler is ready to be refired.

When burning a high-volatile low-fusing-temperature ash fuel, over-fire air jets often aid burning the particles in suspension and help decrease smoke. Cinder traps and collectors are usually incorporated with spreader stokers to catch the finer coal and ash particles carried out with flue gas. These particles may be returned to the stoker hopper or to the furnace for reburning. This may produce substantial fuel savings. But the fines may interfere slightly with even combustion because ash percentage is increased and volatile content is lowered.

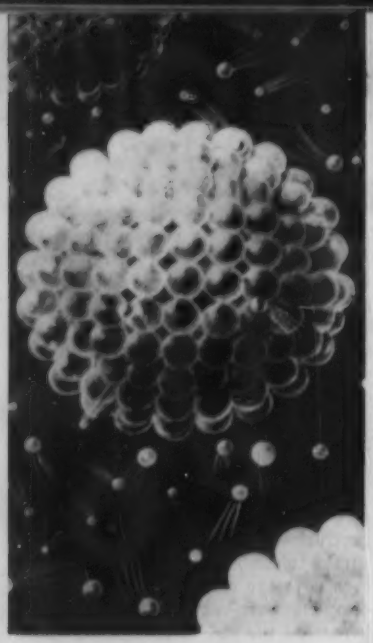
COMBUSTION AIR

Oxygen for fuel combustion is normally taken from the atmosphere. It must be supplied in correct amounts and places for good furnace operation and most efficient fuel use.

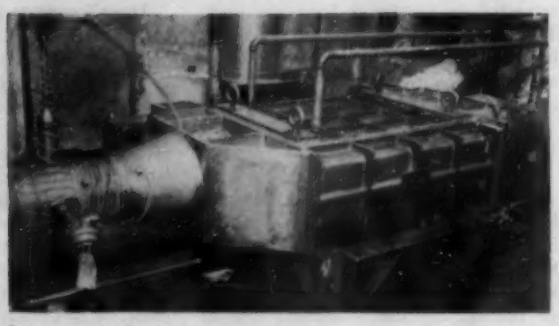
The right amount of air per pound of fuel burned varies widely, depending on fuel components and heating value. But oxygen or air required per pound of steam produced is relatively uniform for the same general type of fuel. So this relation is widely used in steam flow-air flow meters and combustion-control equipment.

Where the ratio of hydrogen and carbon in the fuel varies considerably, the air required also varies. Because of its higher heating value per pound and higher combining rate, hydrogen needs

(Continued on page 210)



NUCLEAR-ENERGY STUDY COURSE: NUMBER 14



1 Linear flat-bed induction-type electromagnetic pump develops a total head of 37 psi with 1200 gpm of sodium coolant

When the reactor designer starts working with radioactive materials he must gear his thinking to new kinds of power-plant problems. Urgent need for high reliability and long life lead him to use . . .

Novel equipment for coolant systems

By HENRY C SCHWENK, *Henry Pratt Company*
and ROBERT H SHANNON, *United Engineers and Constructors, Inc*

► LAST MONTH we talked about materials and the jobs they must do in atomic reactors. Now let's turn to some of the component parts and circuits in a reactor, that is, the fabricated materials.

Getting heat out of the reactor falls to the coolant system as its job.

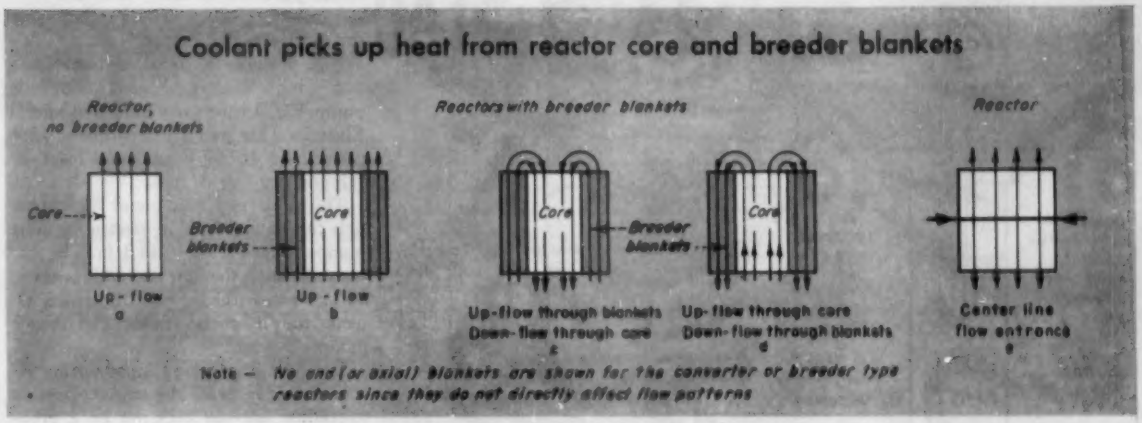
Coolant flow pattern within and between reactor and heat exchanger or boiler depends on many factors: (1) reactor type (2) neutron flux and heat-generation patterns in reactor core (3) heat-transmission conditions (4) effect of coolant flow and pressure loss on component design (5) use and location of moderator (6) removal of decay-heat energy (7) thermal stresses (8) pressure and temperature differentials (9) fuel-handling conditions (10) sealing problems (11) piping-system transient forces. The designer must consider all these factors to lay out a good system.

Type of reactor can vary widely—thermal or fast—burn-up, converter or breeder. Coolant-system layout also depends on arrangement of the reactor core and whether it has end-blanket sections or radial-blanket sections used as neutron reflectors or for converting fertile material. Control-rod design also plays a part in patterning the coolant system.

Fig. 2 shows some coolant flow patterns for solid-fuel reactors. Each one must be studied for: (a) ability to remove reactor decay heat-energy with complete loss of pumping power (b) effects of pressure and temperature on reactor-vessel design (c) piping and equipment size needs (d) pumping power (e) effects on control and fuel-element handling equipment.

The neutron-flux and heat-generation patterns in the core vary with fissionable-material enrichment and can be changed by so-called "flattening" or "seeding" of core (see No. 9, April 1955, POWER, pp 88-89).

Chopping off the chain reaction in a reactor does not immediately stop all heat production. Residual radioactivity of the core continues to generate heat (decay heat) that can damage the reactor if not removed. The coolant system must carry away decay heat even if all pumping power should be lost.


Coolant picks up heat from reactor core and breeder blankets
Reactor, no breeder blankets
Reactors with breeder blankets
Reactor
Core
Breeder blankets
Core
Core
Breeder blankets
Core
Up-flow a
Up-flow b
Up-flow through blankets Down-flow through core c
Up-flow through core Down-flow through blankets d
Center line flow entrance e
Note – No end (or axial) blankets are shown for the converter or breeder type reactors since they do not directly affect flow patterns

2 Coolant flow through reactor cores and surrounding breeder blankets can be arranged in a number of ways, as shown a to e. For safety, the coolant should be able to remove reactor decay heat by natural circulation if all the pumps are lost

The coolant-system arrangement and number of loops depend on: (1) type of reactor and vessel (2) type of coolant fluid (3) accessibility of components for inspection and repair (4) number and type of components in system (5) construction method (6) material chosen (7) testing methods (8) expected operating conditions—start-and-stop frequency, stepped transient conditions, thermal shocks (9) operation and maintenance experience with other similar systems.

The number of loops depends particularly on holding piping and components to reasonable physical size. This, in turn, depends on flexibility needed to accommodate thermal expansion in the system. Caution must be used in extrapolating the experience with small experimental reactors to larger commercial sizes.

Number of primary-coolant loops in most existing or proposed reactor plants varies from 2 to 12—one extreme case proposes 36. Considering the decay-heat problem, three might be a reasonable minimum. A double failure would leave one to remove decay heat. If only one failed, the remaining two could run the reactor at about 70% rated capacity.

Secondary-coolant loops are used depending on the type of reactor and its primary coolant. The secondary loop is an intermediate heat-transfer link between primary-coolant loop and the turbine (see No. 10, May 1955, p 95). The combined problem of exclusion area and containment of reactor, in an accident, influences the design of the secondary loop. Secondary-loop pressure should be higher than the primary if a leak develops in the heat exchanger. This prevents contaminating the secondary loop with radioactivity. The main purpose of a secondary loop is to eliminate radioactivity in the steam-water power cycle of the plant.

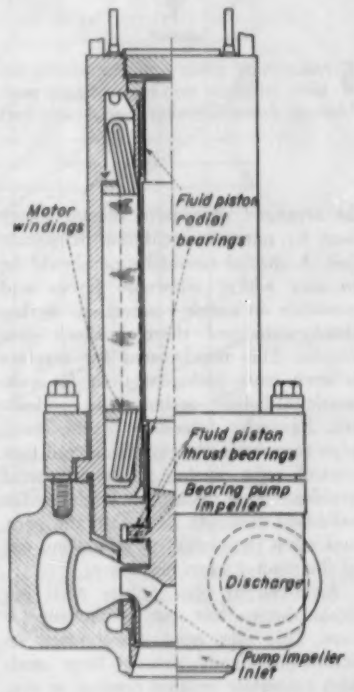
In Part 9, April 1955, pp 90-91, we discussed the choice of coolants. The secondary-loop coolant should be compatible with both primary coolant and power-cycle fluid. It should satisfy physical, heat-transfer, safety and cost requirements.

When using Na as the primary coolant and water-steam as the power-cycle fluid, we can use NaK as the secondary coolant to eliminate (1) the hazard of reaction between radioactive Na and water and (2) radioactivity in the steam. Neutron shielding around the secondary loop near high-flux regions of the reactor keeps radioactivity low in the secondary coolant.

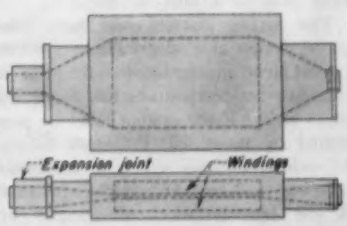
In a fast reactor a liquid-metal secondary coolant eliminates the hazard of carrying neutron moderating elements (H, C, etc) into the reactor by the primary coolant. Accidental entry of moderators could cause a runaway accident.

Piping systems for coolants must be designed to withstand corrosion and mass transport problems discussed in No. 13, Sept, pp 98-100. In addition, they require high resistance to radiation damage, steady-state stresses and thermal shocks. Fluid velocity pressure loss must be balanced to achieve good hydraulic design and economical pumping-power needs.

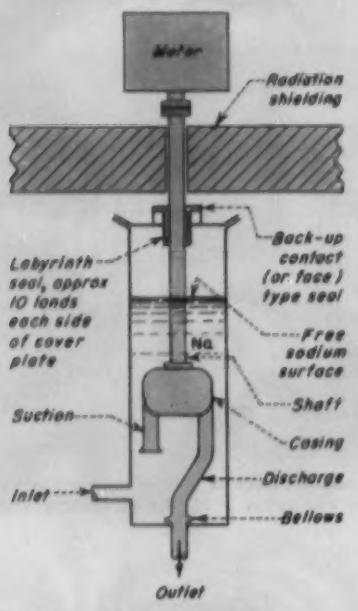
The systems have to be leak-tight to contain radioactive fluids. Piping should



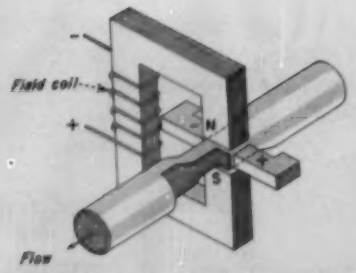
3 Hermetically sealed pump uses fluid pumped to lubricate piston bearings



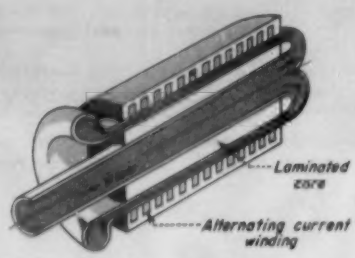
4 Internal arrangement of ac electromagnetic pump shown in Fig. 1 photo



5 Mechanical sump pump for sodium has both labyrinth and contact-type seals (Atomic Power Development Assoc, Inc)



6 Direct-current faraday-type electromagnetic pump has field coil, yoke



7 Reverse-flow electromagnetic induction-type pump simplifies connection (Allis Chalmers Manufacturing Company)

be arranged to remove reactor decay heat by natural circulation if pumps fail. A special consideration should be to stay within allowable forces and moments on nozzle connections during steady-state and thermal shock conditions. This requirement for reactors is even more stringent than for conventional boilers, turbines and condensers. Excessive forces at reactor-vessel pipe connections might distort and lock control rods causing a major reactor accident. Such distortions might wedge solid-fuel elements tight into the core, making it impossible to take them out of the reactor when necessary.

An external pipe failure must not drain the coolant out of the reactor core. This may need a secondary reactor-containment vessel, loop seals with automatic vacuum breaker or continuous bleed lines, or other schemes. A thin seal-welded sheet-steel cover over piping and equipment insulation can act as a secondary back-up if a weld fails or a leak develops.

The piping system must have adequate drains and vents where needed. Liquid-metal piping has to have preheat systems—for components too. Since Na melts at 208 F the system must be preheated to about 300 F before filling. All-welded designs are best for loops carrying radioactive coolant because of the inaccessibility of flanged or screwed joints for maintenance. Flanged joints have been used for inert-gas systems at about atmospheric pressure in radioactive regions.

Pumps. Moving the liquid coolants through their loops involves some major pumping problems. Pumps handling radioactive fluid must have zero shaft leakage. The "canned-rotor" pump has been developed to meet this need. The pump motor, a hermetically sealed unit, has both a hermetically sealed stator and rotor. Fig. 3 shows an Allis-Chalmers unit, the bearings run in the fluid being pumped whether water or a liquid metal. This pump features a fluid-piston-type bearing specially adapted to liquids with poor lubricating properties. The canning or sealing materials around the motor windings add to the air-gap loss. The electrical insulation must stand up under nuclear radiation and the heat-removal system has to keep insulating materials below maximum allowable temperature.

Electromagnetic pumps. Since pump reliability is of utmost importance a unit with no moving parts would be useful. We have such pumps for liquid metals, which are fairly good conductors of electrical currents. With an alternating-current source, basic principles are the same as for an induction motor. The ac in a suitable winding builds up a moving magnetic field. This induces an electric current in the liquid metal flowing through the winding. The induced current has its own magnetic field, which reacts with the winding field and forces the individual liquid-metal particles to move with the moving magnetic field. These pumps are the electromagnetic type.

Fig. 4 shows a so-called linear flat-bed induction-type electromagnetic pump. Fig. 1 shows one built by General Electric. This pump moves about 1200 gpm of Na at 500 F against a total developed head of 37 psi.

Thickness of liquid-metal flow channels for Na and NaK in electromagnetic pumps ranges from ½ to 1 in. The material forming the flow channels is about 50 to 60 mils thick—this dimension affects the magnetic fields and hence pump efficiency.

The pumping energy input during reactor outages, with the coolant system operating, may or may not be a problem. During start-up this energy will help bring the system up to temperature.

Transition pieces between the very thin but wide flow sections of the linear-flat-bed-type pumps and the piping require careful designing. Thermal expansion must be allowed for in the liquid-metal circuit.

Many other types of pumps have been used, or considered, for handling radioactive coolants. Some have run successfully and others are still undergoing research and development.

Shaft seals. There has been considerable development on a frozen-type shaft seal for mechanical-type pumps for Na. This uses a shaft sleeve with embedded cooling coils and a separate coolant circuit to keep temperature below 150 F (Na melts at 208 F). Because of a reaction hazard between water and Na, other liquid metals or hydrocarbons can be used as the sleeve coolant. For example, various NaK alloys freeze at temperatures ranging from 12 to 80 F. Hydrocarbons could not be used with a fast reactor because of the moderating effect of hydrogen and carbon in case of a leak.

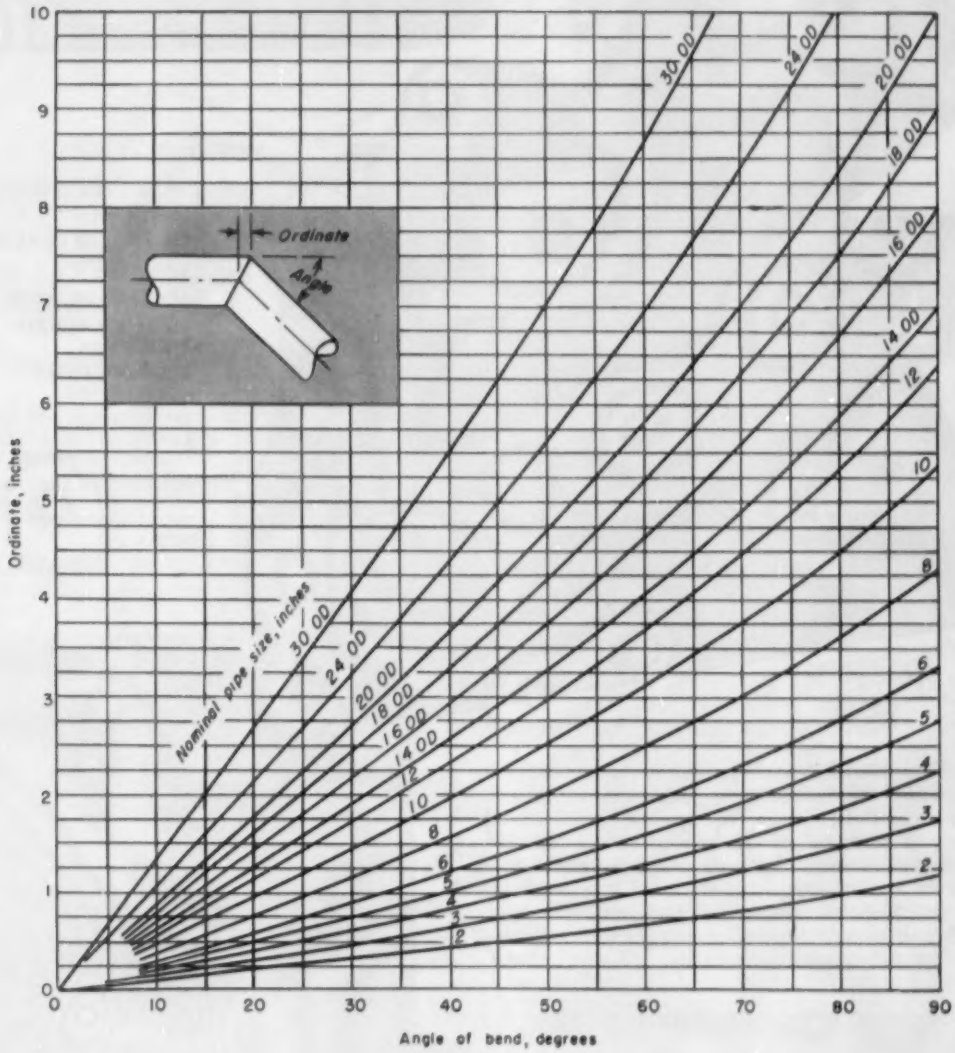
Radial clearance between sleeve and pump shaft runs about 10 to 20 mils. Sodium in the clearance space is solid except for a thin film adjacent to the rotating shaft kept liquid by the heat of friction. The sleeve length and radial clearance needed for zero leakage depend on shaft diameter, rpm, operating temperature, etc.

After a cold shutdown, the starting torque must break loose the solid sodium around the shaft. The frozen sodium may raise a problem by acting as a diffusion cold trap and collecting impurities that will score the shaft and reduce the sealing effect. A mechanical-sump-type pump with a frozen-shaft seal, using toluene as shaft-seal coolant,

(*Continued on page* 204)

Power's DATA SHEET

No. 280



Angles for fabricated-pipe bends

► When building up welded pipe bends this chart will help to lay out accurate cuts. Sketch shows how pipe should be measured from center line to find the ordinate. This chart holds for welded and seamless-steel pipe.

The chart is figured from the formula:

Ordinate = actual pipe radius × tangent of ½-bend angle

If the pipe that you want to fabricate differs from standard, use the formula instead of the chart to get the proper angle and fit.

G A Johnson, *Melbourne, Australia*

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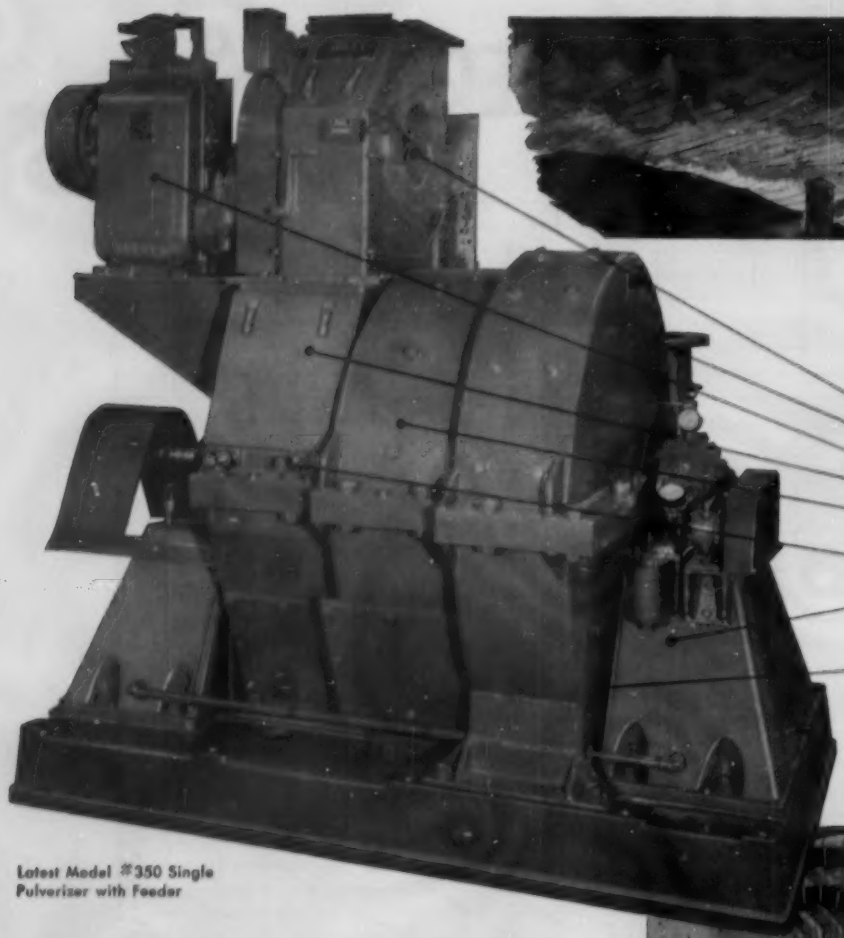

METERING COAL FEEDER*
PULVERIZED COAL OUTLET
VARIABLE SPEED DRIVE
CRUSHER-DRYER SECTION
MAIN PULVERIZING SECTION
CRUSHER BLOCK ADJUSTMENT
OIL STORAGE FOR BEARING LUBRICATION SYSTEM IS INSIDE THE PEDESTAL
PULVERIZER SECTIONS ARE MOUNTED INDEPENDENT OF BEARING PEDESTALS

*Can be provided mounted on pulverizer, or separately on floor above.

Latest Model #350 Single Pulverizer with Feeder

Riley has manufactured coal pulverizers since 1925. In 1950 the Riley "50" Pulverizer Series was introduced. Tough, durable Tungsten Carbide applied to pulverizing parts provides extra long continuity of service and low maintenance even with high ash coals. In addition, a crusher-dryer section precrushes the coal, rejects foreign material, and flash-dries the wettest coals, with the result capacity is maintained. Illustration at right shows moving pegs and the pulverizer's accessibility.

#550 Duplex Leaves Riley's Detroit Plant for Colorado

The #550 Duplex, the largest model, is actually a combination of two #550 Single Pulverizers and has a 46,000 lbs/hr rated capacity with 50 grindability coal. Public Service Co. of Colorado has installed seven of these units. Detroit Edison Company has ordered six Duplex Units for a steam generating unit with a capacity of two million pounds per hour.

Cross section of typical #550 Duplex Pulverizer. Coal enters crusher-dryer section (at ends) — here it is precrushed, flash-dried and tramp iron is rejected. Coal is pulverized to required fineness in second sections by attrition. Coal, uniformly mixed with air is blown to burners (center sections).

RILEY DESIGNS, MANUFACTURES AND INSTALLS COMPLETE STEAM GENERATING UNITS AND

Even *Hurricane Rains* can't lower capacity of Riley Pulverizers

Let it rain . . . let it pour . . . seven to twelve inches or more . . . the flash drying feature of the crusher-dryer section of the Riley Pulverizer will eliminate any amount of moisture in coal . . . even when water actually runs out of the feeder.

To prove this statement read this report made by a Riley Engineer after last year's hurricane CAROL —

"Last week, we visited a power plant of a Southern New England Public Utility to observe operation of the new Feeder-Crushers. The Chief Engineer stated he feels they are saving on pulverizer maintenance and most important on unit outage. The first of last month during hurricane "Carol" it rained 5 to 6 inches on their coal pile. They burned coal with water running out of it with no load drop for the first time in the plant's history."

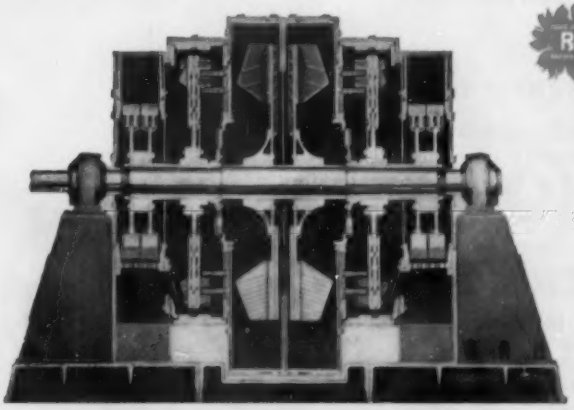
Since this report was written this power plant has operated continuously and without loss of load through hurricanes Edna, Connie and even Diane with its torrential rains. Thus, you can be assured that as long as they are not engulfed in flood waters Riley Pulverizers equipped with Riley Feeder-Crushers will maintain capacity even with the wettest coals. What's more, Riley Pulverizers have tungsten carbide faced pulverizing parts to efficiently pulverize, with low maintenance, even the most abrasive coals . . . coals containing over 20% ash. Riley Pulverizers will also maintain stable flame at the burners over wide load ranges.

Some other Riley Pulverizer advantages:

- No metal to metal contact
- Quiet, vibrationless operation
- Low foundation cost
- Small overall space
- Insignificant Btu loss with rejections
- Ease of maintenance
- No adjustments required for fineness
- Ability to use high primary air temperature with increase in efficiency
- Minimum of lubricating difficulty
- Ease of automatic regulation
- No auxiliary air required for sealing
- Minimum explosion and fire hazard

A few Public Utilities sold on Riley Pulverizers

Public Service Co. of Colo.	Columbus & Southern Ohio Elec.
The Potomac Edison Co.	Iowa Illinois Gas & Electric Co.
Detroit Edison Co.	So. Carolina Public Service Auth.
Monongahela Power Co.	City of Owensboro, Kentucky
Utah Power & Light Co.	Upper Peninsula Generating Co.
Northern States Power Co.	East Kentucky Rural Electric Coop.
Hartford Electric Light Co.	Dairyland Power Cooperative
Corn Belt Power Coop.	Superior Water Light & Power Co.
Taiwan Power Co.	The Western Colorado Power Co.
Interstate Power Co.	Central Ohio Light & Power Co.
Central Iowa Power Coop.	Connecticut Power Co.



A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs.

RILEY
Stoker Corporation

WORCESTER, MASSACHUSETTS

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FUEL BURNING EQUIPMENT FOR PUBLIC UTILITY AND INDUSTRIAL POWER AND HEATING PLANTS

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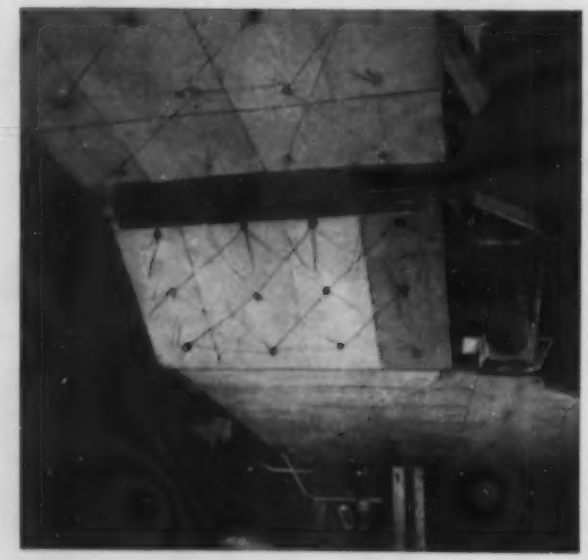

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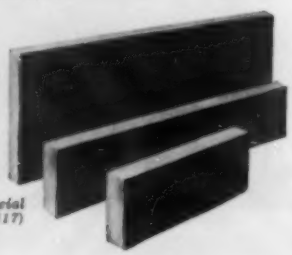

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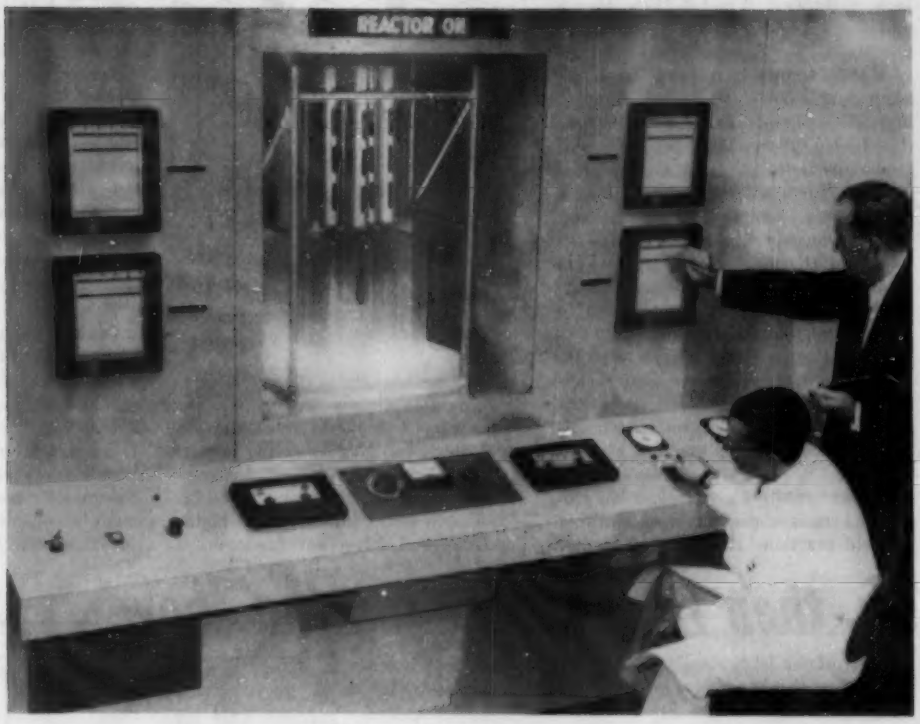
STEVE ELONKA
Associate Editor in Charge



Simulator instruments and controls respond just like a real unit, show you . . .

What it's like to run a reactor

By L N ROWLEY
Editor, POWER

► FOR THE FIRST TIME, not long ago, I had the experience of operating a nuclear reactor. Chances are your first feel of reactor controls will come the same way—not on an actual unit but on a simulator that faithfully imitates the behavior of the real thing.

My first trick at a reactor's controls was on the simulator pictured above, which was previewed for technical editors before its official unveiling at the Instrument Automation Exhibit at Los Angeles, Sept 12-16. Its makers, Leeds & Northrup Co of Philadelphia, believe it to be the first nuclear-reactor simulator to be offered commercially for training and research.

As we swing into large-scale use of nuclear power, we're going to need a whole new generation of operating men, schooled in the fission process and its control. How are we going to train them when costly reactors are not readily available for instructional purposes? In relatively inexpensive simulators like this one lies an answer for the schools and companies who will do this training job of the future.

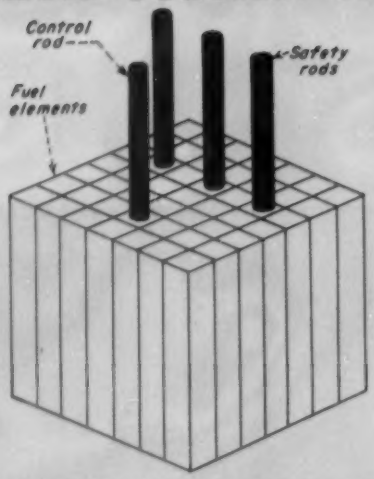
Now, to see what it's like to operate a nuclear reactor, turn the page.

Operating a nuclear reactor: Review the 'why'

To know why nuclear reactors are controlled as the simulator demonstrates (below) we need to review how they work. For a full story, see POWER's Nuclear Energy Study Course, particularly chapters 7, 8 and 9 (Feb, March and April 1955). Here's a quick run-down:

Atomic energy is released when the nucleus of a heavy atom, such as uranium 235, splits or *fissions*. To trigger this fission process, we use neutrons, atomic particles carrying no electrical charge. When a flying neutron hits a nucleus and is captured by it, the nucleus becomes unstable. It breaks up into two lighter atoms and ejects several spare neutrons (2.5 on the average). These newborn neutrons can, in turn, cause other U-235 nuclei to fission, ejecting more neutrons, and so on. But newborn neutrons can also be absorbed without causing fission, or can escape. When each fission triggers at least one new fission, we have a *chain reaction*.

Nuclear reactors are devices for producing, maintaining and controlling a chain reaction. One type of reactor



REACTOR CORE, much simplified, shows safety and control rods, fuel elements

core contains closely spaced *fuel elements* with a *coolant* circulating between them to carry away the heat of the nuclear reaction. The fuel may be natural uranium, containing about 0.7% U-235, or may be enriched with higher percentages of this *fissionable* material. (In this quick run-down we'll ignore other fissionable materials like *plutonium*, and *fertile* materials that can be made fissionable.)

Neutron losses in such an assembly occur in a variety of ways. Some neutrons leak out of the core and escape. Others are absorbed in the reactor structure, and the nonfissionable atoms of the fuel elements. The designer's problem is to proportion the elements and select the materials so enough neutrons are available to set up and maintain a chain reaction. Often he uses a *moderator*—a material that slows down the neutrons and so increases their chances of capture by fissionable nuclei. In many reactors, the coolant is used as a moderator.

Reactor control may be provided in several ways, but a common scheme uses movable rods of materials like cadmium or boron that absorb neutrons. The core is designed so when rods are withdrawn there are more than enough neutrons to sustain a chain reaction. By partly inserting the rods, just enough neutrons are absorbed to hold the chain reaction at desired level.

. . . then read below for the 'how'

Heart of the L&N simulator is an analog computer (numbered 1 on the key drawing, right). This unit is the electronic equivalent of an actual reactor core, and responds to control action in the same way. By means of adjustments and plug-in elements, its characteristics can be changed to match different reactor arrangements, fuels, etc.

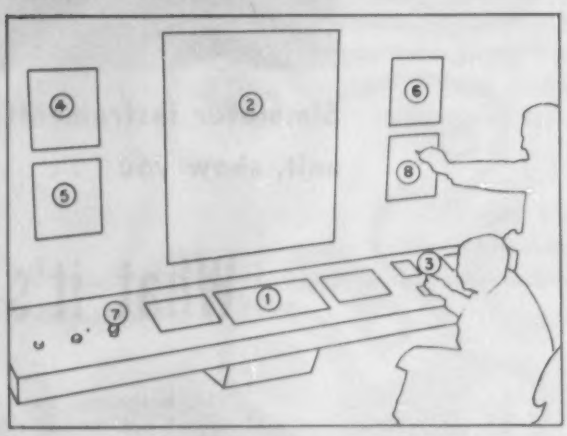
A reactor model, with plastic dummy fuel elements and working control rods, occupies the center of the panel (2). Operator manipulates rods by means of a control handle. Adjacent indicators (3) show rod position in percent of travel. Reactor model pictured (photo, preceding page) represents the so-called "swimming-pool" type, with a pool of water acting as both coolant and moderator. Operator can see rod motion and the model even simulates the blue glow (Cerenkov effect) that characterizes this type of reactor during power operation.

Quick run-down of reactor operation (above) reveals that neutron population is a key factor in control. To keep tabs on population, reactor instruments measure neutron density.

From startup to full operation the range of neutron densities is enormous—from zero to 100 million or even 100 billion. To give accuracy over this range, and particularly in the crucial low-density startup interval, the range is divided into parts, each with its own instrument.

During startup, when neutron densities are very low, activity is detected by a fission chamber. Neutron collisions are counted individually. Amplified pulses feed a log-count rate meter, whose signal operates a logarithmic recorder and indicator (4). This detecting system is also tied to the rod interlocks.

Higher neutron densities, beyond scale range of the log-



KEY TO CONTROL OPERATIONS is given by numbers on outline of nuclear-reactor simulator photograph on the preceding page

count meter, are measured by a compensated ionization chamber, feeding an amplifier. One output of the amplifier goes to a log-N recorder (5), giving a record and indication of neutron density. Another output of the amplifier is the rate of change of the logarithm of the power level. This goes to the period recorder (6).

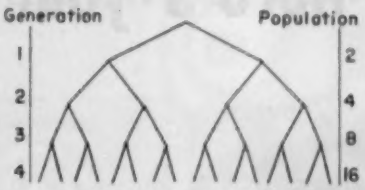
Reactor period measures the rate at which neutron density changes and is of prime concern to the operator. It

With this quick picture of the basic parts of a reactor, we're ready to take a closer look at the control angle.

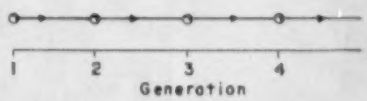
Key factor is that fission is a multiplying process. When a single neutron causes a fission we get several new neutrons. Let's say we keep losses low and two neutrons are left for new fissions. At this rate, next generation will contain 4 neutrons, next 8, and next 16. At such a reproduction rate (2 for 1), the neutron population reaches staggering figures in only a few generations.

This multiplying action is expressed by a factor, k, which may be defined as *ratio of number of neutrons in one generation to number in the preceding generation.* If k is greater than 1, the number of neutrons grows. If it exactly equals 1, the neutron population stays constant. If it is less than 1, population dies out. Moving the control rods to absorb more or fewer neutrons varies value of k.

Power level, or heat output, of a reactor depends on neutron population. This is usually expressed as *neutron density*—the number of neutrons per unit volume—or *neutron flux*—the number of neutrons passing through a unit area in a unit time. A production of about 7.5×10^{10} (75 billion) neutrons per second is equivalent to a heat output of 1 watt.



NEUTRON POPULATION grows fast in a few generations with 2.1 reproduction



WITH 1:1 RATIO, chain reaction holds steady level, produces constant energy

Let's say we have a reactor operating at some steady power level. Multiplication factor k is 1. To keep things simple, we'll assume a neutron density of 100. We want to double reactor power level, so we withdraw control rods slightly. Fewer neutrons are absorbed and k factor increases—let's say to 1.1. Starting with 100 neutrons in a given volume, second generation would be 110, third 121, and so on. By the eighth generation we'd have a neutron population close to twice as large and nearly double the heat output. To stop population growth, we move control rods back to position where k is 1. Reactor then holds at new power level.

Allowable rate of neutron multiplication is actually vastly lower than the 1.1 assumed above. A new generation of neutrons forms in an incredibly short time (0.000000000001 sec). We couldn't move fast enough to control this dizzy rate of growth except for one fortunate characteristic. About 0.76% of the neutrons in each generation are *delayed*—ejected from a few seconds to several minutes after fission. This gives the margin needed for control if multiplication factor is kept below about 1.007.

is a logarithmic function and may be defined as the time in seconds for neutron density to change by a factor of 2.718. It is usually considered desirable to keep reactor period above 10 sec when bringing the unit up to desired power level. An output from the log-N amplifier feeds safety circuits, which drop or "scram" the control rods if period exceeds a preset value. A manual scram button (7) permits the operator to drop the rods in any emergency.

Automatic control of power level is provided by a linear servo channel. When the reactor goes "critical" (reaches a self-sustaining chain reaction) neutron density or power level shows on the recorder and controller at (8). Unlike the log-count and log-N recorders this has a linear function. It measures neutron density by a compensated ionization chamber and special microammeter. The recorder-controller unit, in turn, feeds an amplifier and servo operating the control rod.

Once desired power level is reached and control switched to "auto," the servo holds power level constant at any preset point. It also controls changes of power level.

Typical operating sequence begins when safety control rods are withdrawn. Then operator manipulates control handle to slowly raise the rod used for operating control. Rod position indicators show rod motion and, in addition, the student operator can see the rod move in the reactor model. (Rod motion in an actual reactor can't be seen.)

As he slowly withdraws the control rod, the operator watches the log-count recorder for a measure of neutron density, and the period recorder, to keep rate of increase within safe limits. If he lets rate of increase get too fast, safety controls scram the rods.

During this startup, neutron density reaches limit of the log-count scale and appears on the log-N scale. As neutron density increases, the critical point is reached. Operator continues to withdraw the control rod, watching power level on the linear scale (8), until power level is at the desired point. He then switches to automatic control and the power level is held constant at the set point.

To raise power level, control rod is withdrawn slightly. The multiplication factor then exceeds 1, and each succeeding neutron generation becomes larger than the last. When desired new power level is reached, control rod goes back to its former position and k becomes 1 again.

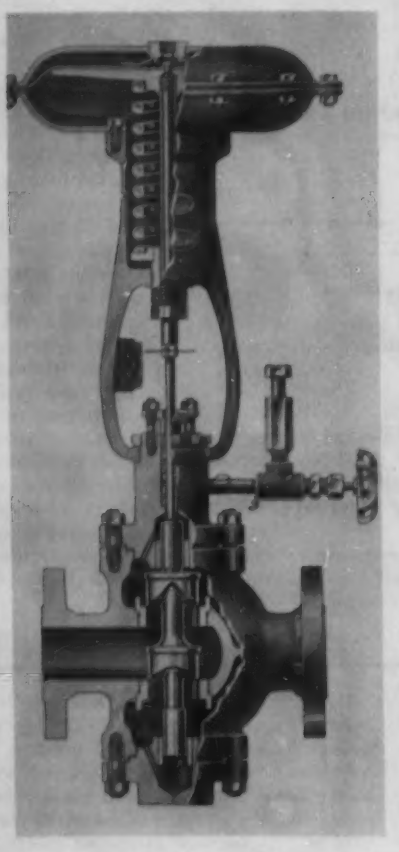
At first blush, this business of returning the control rod to its former position looks queer to old hands at boiler-furnace control. When you want to boost the firing rate, you open the fuel valve wider, and leave it at the new position. The heat release is roughly proportional to the fuel flow and that, in turn, to the valve opening.

In a reactor, heat output is proportional to neutron density. As explained above, we increase neutron density by letting the population grow a bit, then level it off at the new, higher point. Control-rod position is not proportional to neutron population. It regulates the growth of that population and thus changes only during the interval when population changes. Thus, regardless of power level, the control position should be essentially constant at the point where k equals 1 and the reactor is exactly critical.

In practice, rod position will shift slightly. As fission products build up in the fuel elements, neutron loss increases and the rod will have to be withdrawn slightly to compensate. The servo handles this automatically.

OPERATORS' NOTEBOOK 90

Here's your air-operated



How the control valve works . . .

AIR PUSHING DOWN on the diaphragm provides power for working this control valve. Valve shown has direct-spring return; also made with reverse-spring return, where air pushes up under diaphragm. Increase in operating air pressure above the initial spring setting, of 3 psi for 3- to 15-psi range, pushes motor stem down. This motion is opposed by the spring compression.

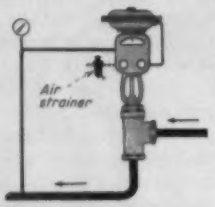
Resulting valve action is known as air-to-close when valve plug is moved toward valve seat; air-to-open when plug is moved away from seat. Either action is from direct motor where design permits inverting valve body and plug. Where design doesn't permit air-to-open action with direct motor, use the reverse-motor type (not shown).

Stop in upper case holds initial diaphragm position. Spring is normally set so motor stem starts to move when air pressure to diaphragm is equal to the minimum spring range. Compression can be changed with external adjusting screw.

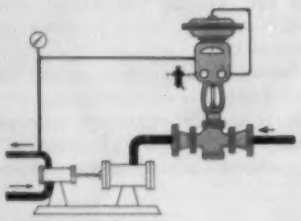
Spring load is carried by a ball-thrust bearing in motor having more than 100 sq in. effective diaphragm area. Ball reduces force needed to adjust. It also minimizes torsional stress imposed on spring under compression. Travel indicator shows exact plug position between full open and full closed.

Plug design is important. It directly governs flow through valve. Two most common types are double-seated top-and-bottom guided V-port (shown) and parabolic plug (not shown).

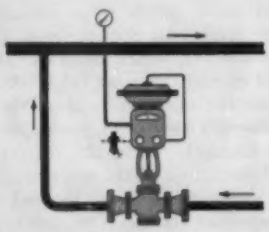
Some applications . . .



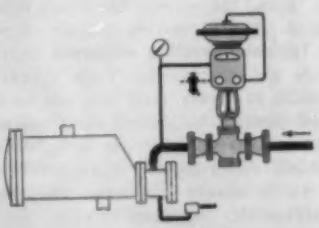
HIGH-PRESSURE GAS to transmission line is usually reduced. The angle valve shown is recommended for this service



DISCHARGE PRESSURE on steam-driven reciprocating pump may be held closely by controlling the steam to the pump



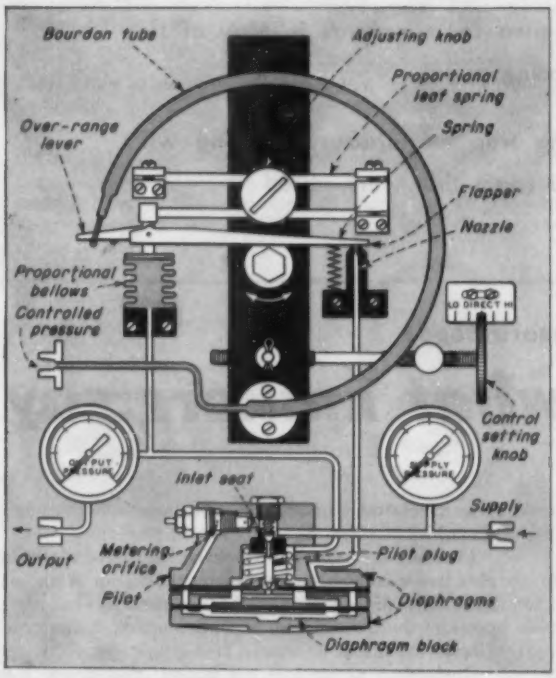
STEAM MAKEUP to low-pressure process or heating. A second controller can relieve the excess on the light loads



HEATING-STEAM PRESSURE to reboilers and heat exchangers is controlled to meet the exact process requirements

diaphragm-controlled valve

By STEVE ELONKA
Associate Editor



Pressure controller is this valve's brains . . .

In previous Operators' Notebook we learned that a control valve has a pilot valve. Small pilot is either built inside the larger regulator body or is placed on outside. Pilot of this control valve is part of the pressure controller placed on outside of valve; it is connected to valve's diaphragm.

Supply air passes to under side of pilot plug. A little air passes through metering orifice and serves as nozzle supply. When nozzle is covered by flapper, these things happen: (1) Nozzle pressure builds up on top of upper diaphragm. (2) Diaphragm block moves downward. (3) Pilot plug seals exhaust seat in diaphragm block and opens inlet seat. (4) Output pressure builds up under lower diaphragm. (5) Diaphragm block moves upward.

Inlet seat remains open until equilibrium is reached between nozzle pressure and output. When thus balanced, there's no flow of air into or out of pilot—theoretically. But small bleed between supply and outlet increases pilot responsiveness when at equilibrium.

Decrease in nozzle pressure opens exhaust seat, allowing output air to escape between two diaphragms—through horizontal ports in intermediate plate. Ratio of effective areas between upper and lower diaphragm is such that a change of about 3.5-psi nozzle pressure causes output pressure change of 3 to 15 psi.

Flapper pivots on pin at movable end of proportional bellows. Bellows is connected to output pressure from pilot. Travel of this bellows is proportional to output pressure.

Increase in controlled pressure causes free end of bourdon tube to move flapper clockwise, tending to cover nozzle and increase output pressure.

Proportional (feed-back) bellows tends to lower flapper bearing, causing flapper to cover nozzle. In normal operation, reaction of pressure in proportional bellows keeps flapper in position to throttle a steady output pressure.

Movement of feed-back bellows is proportional to: (1) movement of free end of bourdon tube (2) output pressure of pilot. So output pressure must be exactly proportional to movement of free end of bourdon tube.

Function of proportional band-adjustment knob is to vary effective length of proportional flexure rod.

Control-setting knob is for setting controlled pressure. Index setting scale directly above knob has graduated reference marks between LOW and HIGH. Direction knob is moved along scale; indicates effect of adjustment.

Range of pressure is for 0 to 10,000 psi, but all bourdons furnished will withstand 25% overpressure without damage, according to manufacturer. Standard controller takes clean dry air or noncorrosive gas at 20 psi. Air set of reducing-relief valve with filter-drip-well is good insurance in air-supply line as shown in application sketches. *Courtesy: Mason-Neilan Regulator Co, Boston, Mass.*

- **Arnold Bogart of Los Angeles tested some traps, found that capacities were apparently below the manufacturer's ratings**
- ***Power* published his findings and plea for standards in May of this year (see excerpts at top of the facing page)**
- **Proofs of his letter went to leading trap manufacturers, along with *Power*'s invitation to discuss the questions that were raised**

Are actual steam-trap capacities less than guaranteed?

Here's what makers say

As the three letters below make plain, testing and rating steam traps isn't as simple as it sounds. Here are several points that stand out:

1. Trap capacity is strongly influenced by condensate temperature, by valve action, by effect of connections

2. Rating methods in use take account of some or all these factors

3. Leading makers specify conditions under which their ratings are established

4. A standard procedure for testing and rating would eliminate confusion, permit accurate comparisons of trap performance

Sarco Company, Inc:

While we do not entirely agree with Reader Bogart's findings, POWER has done a service to the process steam user by publishing his letter.

We have long contended that published steam-trap capacities are meaningless unless conditions under which the tests were made are clearly stated. Unfortunately, Bogart does not tell us the test conditions, nor does he describe his test rig.

From his letter, May, p 140, it appears the condenser used could not produce enough condensate to fully load some of the traps tested. Rated capacity of a trap should be its full-load capacity: that is, maximum quantity of condensate the trap passes when full-open during the test run. Inlet and outlet pressure at the trap and the condensate temperature should be recorded.

Condensate temperature at the trap inlet determines the proportion of flash steam in the discharge orifice. This affects velocity and, therefore, mass flow through the orifice.

Continuous condensate discharge during the test is also important, no matter whether the trap is an intermittent discharge (inverted bucket or balanced pressure thermostatic) or a continuous discharge type (liquid expansion or float).

Remember, as an inverted bucket trap closes, the length of time it stays closed depends on the time to lead steam through the vent hole, not on the condensation rate. Similarly, when a thermostatic trap closes, it stays closed until the thermostatic element cools; this is a function of ambient temperature at the trap rather than condensation rate.

Referring to Bogart's conclusions (top, p 121):

1. Both temperature and backpressure affect flash formation, so pressure drop alone is no indication of trap discharge.

2. Some traps show no leakage when in good condition: for example, the float-thermostatic and the liquid-expansion types.

3. We prefer to say that the following variables affect discharge capacity: (a) inlet and outlet pressure (b) temperature (c) construction.

4. We agree—unless maker states the conditions.

There is no doubt that standard methods of steam trap testing are called for. Maker should also state clearly whether quoted capacities are the result of test or of calculation. In either case, the base of conditions should be given.

A MILNES, *Vice-President*

Strong, Carlisle & Hammond Company:

There are two methods of determining steam-trap capacities: (1) Amount of cold water that will pass through the orifice at full differential pressure for

Highlights of Bogart's arguments for standardization

Discharge capacities claimed by steam-trap manufacturers are in general way above possible theoretical maximums.

I studied steam-trap performance to determine (1) actual discharge capacity (2) thermal efficiency. Results show that actual capacities are only 28 to 43% of guaranteed capacities at rated conditions. Limitations of temperature instrumentation made results of thermal efficiency tests inconclusive. . . .

Comparison of ratings. Here's another point: It is impossible to compare the results of discharge tests of any two traps. Nor can you compare traps on the basis of manufacturers' ratings. No manufacturer shows how his ratings were established. But I do not suggest they deliberately publish misleading information. Many errors result from different test procedures, rating methods, lack of common standards, calculation methods, etc.

Theoretical data. I reviewed available literature to get data on theoretical discharge capacities of steam traps. Here are my conclusions from this work:

1. You cannot predict trap-discharge capacities from knowledge of the pressure drop across the trap alone.

2. Amount of leakage through a steam trap is an inherent characteristic of each of the specific makes of trap.

3. To evaluate discharge capacity properly, consider these variables: (a) pressure differential across trap (b) temperature of discharged condensate (c) flow conditions in the discharge line (d) construction characteristics.

4. Most manufacturers' ratings are not based on condensate at steam temperature, but on hot water at 20 to 80 F below steam temperature. Therefore, guaranteed capacities are somewhat misleading.

A standard method for rating and testing steam traps, to be adopted by ASME or ASHVE, is needed. Otherwise, steam-trap manufacturers should form an institute or association to cooperate with a selected agency and provide the industry with universal means of evaluating steam-trap performance.

---

about trap testing and rating

which trap is rated. (2) Amount of water at steam temperature that trap will actually pass at the indicated differential pressure.

Of course, there is a wide difference between the two methods. The trap is intended to handle water at temperatures either at or closely approaching steam temperature. So capacity should be given in terms of water practically at steam temperatures.

As water temperature increases, its volume increases and specific gravity decreases. So the same volume would weigh less. This, alone, would reduce amount of hot water in pounds per hour as against cold water.

But the change in specific gravity is of minor importance compared with the effect of reflash. This occurs when high-temperature condensate passes through an orifice to atmosphere or a lower pressure.

Most of the reflash may occur beyond the orifice. But part of it occurs inside the orifice itself, causing eddy currents that materially reduce capacity. Differential pressures, temperatures and orifice design affect orifice reflash. Tests show that orifice design alone can cause as much as 60% difference in flow capacity under certain conditions.

The above facts are well-recognized. Practically all manufacturers of bucket traps rate their products on hot-water capacities. And most manufacturers have run enough actual flow tests with all the internal mechanism in place to determine actual capacities.

Remember, the bucket trap functions so the valve is normally wide open when discharging, giving practically unobstructed flow.

In other traps, discharge valve may modulate and barely crack open; then flow is restricted and materially less than the same trap might show on cold water. I also understand that the capacity of certain types of traps is seriously affected by backpressure in the return line.

Broadly speaking, a mechanical (bucket or float) trap passes about the same volume of condensate at any given differential pressure. For example, you get about the same volume when discharging from 150 psi against a 50-psi backpressure as you would discharging from 100 psi to atmosphere. When using any trap other than a bucket or float type, check this point carefully with the manufacturer.

There is no question that Bogart's point has merit. It should be carefully considered in trap selection.

(*Continued on page* 224)

Yarnall-Waring Company:

The conclusion that there is a need for a standard method of rating and testing steam traps has considerable merit. Trap manufacturers have lately made much progress in publishing the basis on which they establish rated capacities.

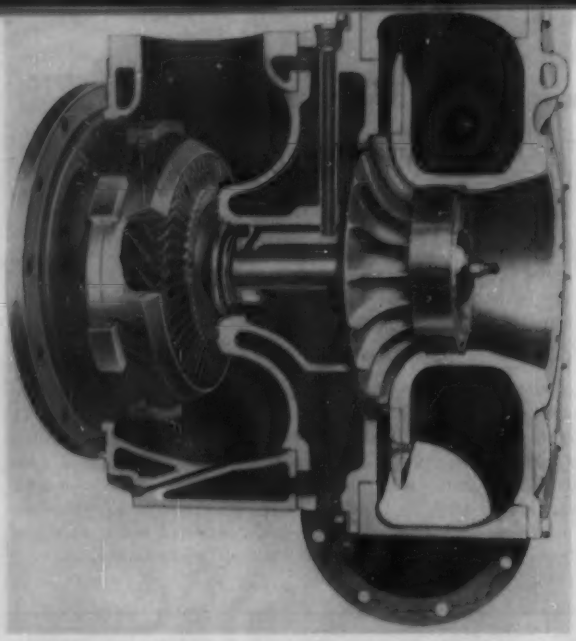
The latest catalogs of nearly all the major manufacturers state that published capacities are determined by actual tests on condensate at a definite temperature relative to the saturation temperature at test pressure. In addition, capacities are defined as the maximum continuous discharge rates.

For continuous discharge, the unit must be completely flooded with condensate at the specified temperature during the entire test period. If steam reaches the trap, it won't realize maximum rated capacity.

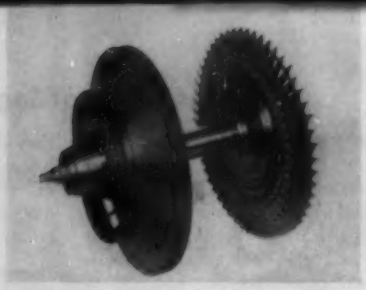
The marked difference between Bogart's experimental capacities and manufacturers' published values was probably caused by the admitted limitations of the experimental condenser and temperature-measuring equipment he used.

Since all three experimental curves start to decrease at approximately 30-psig inlet pressure, trap capacity probably exceeded the available condensing rate at and above this pressure.

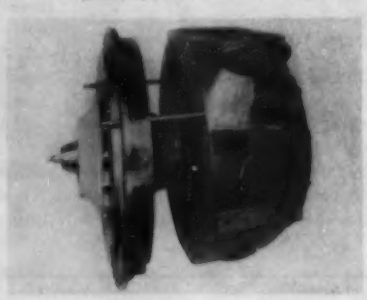
(*Continued on page* 224)



WATER AND OIL keep turbochargers alive. Oil is fed down through vertical tube to bearings, through the water jacket



ROTOR has turbine blades lashed with wire. Single-stage blower is at the left



GUIDE PINS help assemble rotor unit so the castings shown fit into right place

Your turbocharger demands

- **Prime with oil before starting**
- **Clean oil passages, oil filters**
- **Inspect blade lashing-wire**
- **Check shaft oil-seals**
- **Keep oil at right temperature**
- **Know how to start and stop**

6 tips from C Morgan Jones

► ALL THAT was left of the diesel's turbocharger was twisted scrap metal. The relief operator said, "It was running OK when I shut down Friday night. On starting up Monday morning there was a slight knock. I thought it would disappear as the engine warmed up. Next thing I knew the whole place was vibrating. I stopped the engine as soon as I could—but too late."

Here's what happened. When engine was shut down, water remaining in the turbocharger's jackets had boiled, steam pockets had formed. As unit cooled to room temperature, from 1000-1200 F operating temperatures, metal casing distorted. When started, turbine blades touched the nozzle ring. As metal grew hotter from friction, it expanded. Trying to turn faster and faster, it failed completely within minutes.

Damage could have been avoided as turbocharger is a gas-driven turbine and centrifugal blower, on one shaft. There are several types and makes. Shaft may damage. Rotor shafts are supported on two sleeve bearings, pressure-lubricated from main-engine lube system. Some have independent cooling-water and lubricating systems.

If unit starts to vibrate, look for damaged bearings. If lube-oil and cooling-water temperatures climb, stop engine and inspect. Also, check shaft for end play. Use dial indicator. If clearance is greater than maker's limit, replace thrust bearing.

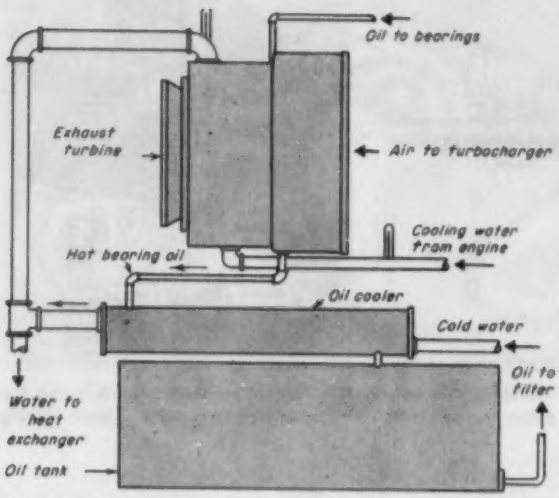
Failure to prime system before starting engine can also cause bearing failure. If you don't prime, unit overheats before oil reaches bearings. Good policy is to fit turbocharger with its own oil-pressure gage. If oil pressure doesn't register on gage after engine runs 10 to 15 seconds, shut down and check for trouble. Hand priming-pumps are valuable. So is nearness of lube-oil tanks to engine.

If turbo's lube tank is placed high enough above engine, with discharge pipe run to tank's top, turbo's oil channels remain full of oil at all times.

Clean oil passages at set periods. Use a pull-through if channels cannot be pushed through. Pull-through should have tail, so you can withdraw it if it jams. If scale and dirt are hard to remove, plug oil outlet at casing's bottom and fill with carbon-tetrachloride. Allow to stand overnight. If this doesn't shift dirt, circulate cleaning solution through system—pumping it in the opposite direction to the oil's normal flow.

Oil filters and coolers must also be checked and cleaned at regular intervals. If system is equipped with pressure-relief valve, keep it clean to avoid pressure loss. Should it open and fail to seat, or if spring weakens and breaks, your charger can burn up.

When engine is overloaded for long periods, high exhaust temperatures may exceed top temperature of oil. To avoid,



LUBRICATING and cooling water hookup is simple. Operator must understand this and know how to keep temperatures right

this care...

reduce load. Or consult oil dealer for a more suitable lubricant.

Independent turbocharger oil coolers need more frequent cleaning than those on main engine. This is true if oil circulates at higher temperatures. That causes heavy deposits in a short time.

Turbine blades are keyed and peened into hubs. They are then tied together at tips, often in groups of four or five, with lashing wire. Wire is soldered to blades. Inspect lashing wires when turbocharger is opened. Clean unit with kerosene, blow dry, then inspect blading, hub, etc, for cracks. Also, check hub key or wiring with hand glass for looseness.

Flats on wiring may not be from wear but were probably filed to balance rotor. Resoldering loose lashing wire takes skill. Make joint same size as adjoining ones. Don't forget one ounce of difference at blade's edge equals one ton when turbo turns at 10,000 rpm. Lashing wire acts as a vibration damper. Remember, very high exhaust temperatures melt solder.

Keep accurate log of rotor speeds. Trouble may be brewing if there's variation at constant throttle speeds. Inspect immediately to head it off.

Turbine blading can be damaged if water collects in casing after shutdown period. Always drain before starting. Allow water to stand in a shallow pan. If oil is present, oil seals may need renewing. You can expect a light oil skim on water, but more oil than that calls for inspection. When engine is running, compare lube oil used with former quantities. This also tells if seal needs replacement. Excessive water in casing might be from minute cracks through cooling jackets. To check, place jackets under hydrostatic test. Have only the manufacturer repair leaks. He usually recommends replacing a fractured part.

Should a turbine blade break or loosen—or any other moving part become damaged—stop engine and block or lock rotor to prevent turning. But don't cut off cooling water. In time, remove damaged rotor and block off exhaust and blower sides of charger. Do this by placing blank flanges on both sides of shaft's bearing bore.

Always use a magnifying glass to inspect turbo's nozzle rings for cracks. If cracks aren't stopped, chunks may tear out, smashing blading and nozzle ring. Pieces of broken exhaust valves can do the same thing. Surface crack may not cause trouble. If deep, drill tiny hole at crack's ends to stop spreading.

Remember when setting valves of this engine that it differs from an aspirated engine. (When not fitted with turbochargers, blowers, etc, engine is known as aspirated or atmospheric.) Exhaust valves close later and inlet valves open earlier. This gives a much larger valve overlap than on conventional engines, but is needed for proper scavenging.

Turbochargers should have vent to prevent air or steam pocket forming in casings.

Separate turbo cooling and lube systems are better than engine-connected ones. This permits using better oils for rotor bearings. If possible, place a hand-operated oil priming-pump in the line, also a separate, independently powered lube pump. Start independent pump several minutes before engine.

When lube pump is driven off main engine, or when lube system is part of engine's system, a pressure of 10 to 15 psi should register on turbo gage within 10 to 15 seconds after engine is started. If not, stop engine at once. Find trouble. Build up a gage pressure of at least 30 psi—preferably 35 to 40 psi in a very short period. This holds for most turbochargers.

Keep oil inlet between 130 and 160 F, but not over 170 F. Discharge must be less than 210 F. Increase is from plugged cooling-water or oil passages. Keep accurate logs of oil and water temperatures. When temperatures start to rise and stay up, clean water jacket and lube-oil passages.

Sight flow-indicators in both oil and water lines are good insurance for quick visual checks. If lube oil returns to engine crankcase, make sure end of piping isn't beneath oil surface.

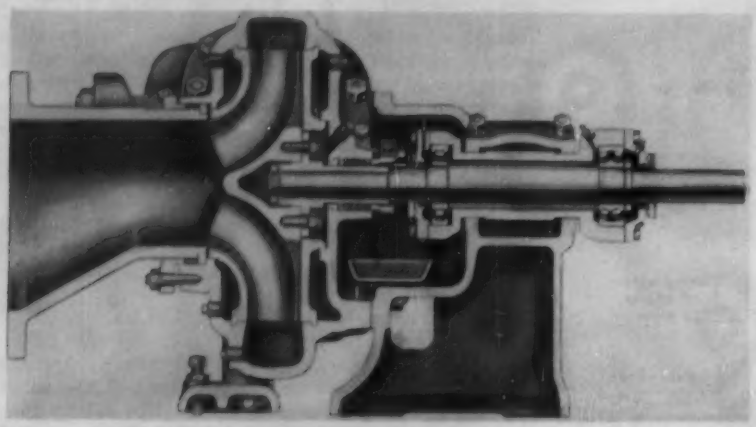
Use clean, soft water in cooling systems. Temperature differences between inlet and outlet should not exceed 30 F. Keep discharge temperature below 190 F and even lower if water used is hard—contains dissolved minerals. Always circulate water through turbo jackets after engine is stopped. It takes only five minutes or so until both inlet and outlet are within 5 to 10 F of each other. This prevents damage from water boiling, reduces chances of thermal distortion.

Water-discharge lines should lead upward to surge tanks. This helps vent water jackets and allows cooling by convection after engine is shut down. If you can't have this setup, place a vent valve at highest point in line or casing to prevent vapor lock and siphoning.

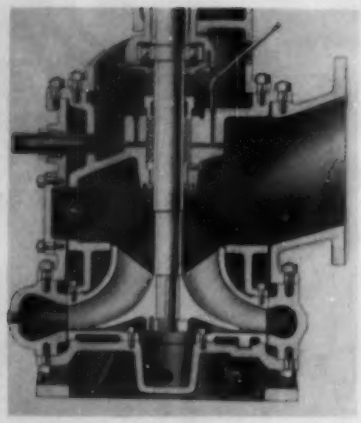
When cleaning, use kerosene or good solvent on nozzle ring, blading, impeller, etc. Don't wire-brush or scrape parts or use soda containing grease-cutting mixture. Use carbon tetrachloride or some similar cleaner.

Don't remove nozzle ring unless a new one is to be fitted. Use pullers to remove and replace bearings. Oil seals, usually held in place by machine screws (one seal at turbine end, other at blower end) must be replaced when they leak, also when renewing shaft bearings.

When oil consumption is very heavy, check seals for leaks. New seals should be coated with Permatex on side away from oil. Also use a good cement on all flanges and other mating surfaces. To help get greater screw and bolt thread life, coat them with a good antigalling compound.



1 Open end-suction impeller and diagonally split casing are found in this horizontal centrifugal stock pump used for all papers, fruit pulps, mashes, etc



2 Vertical centrifugal stock pump has open-type impeller, 2-piece casing

Latest research data give . . .

Seven steps to easy choice of pumps

You'll get best performance from your process pumps if you use the pointers given here on pipe friction, head and capacity corrections, pump selection

By E SCHWANDT,
Application Division, Goulds Pumps, Inc

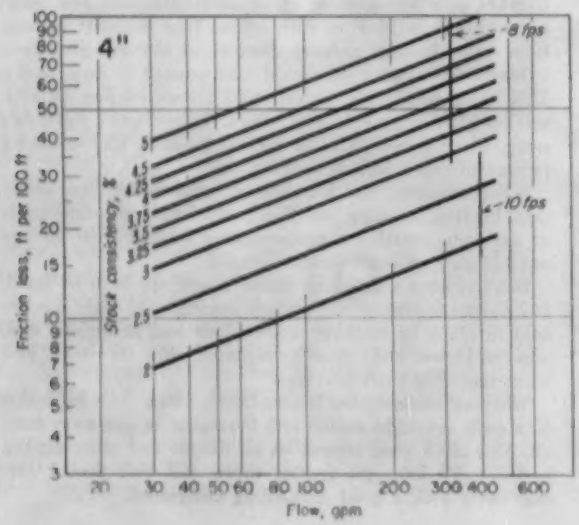
► IT'S DIFFICULT to describe or visualize the fluidity of a mixture of water and fibrous material. But paper stock resembles cooked cereal—say, oatmeal or corn meal—and has similar flow characteristics.

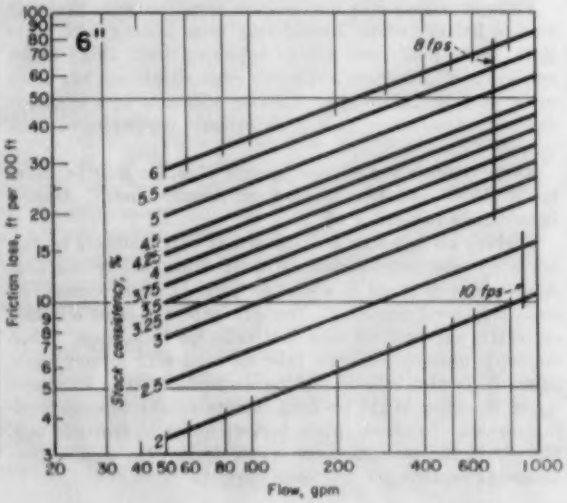
Fluid flow. If we fill a jar with cooked cereal or paper stock, Fig. 3, we will have to tilt it at an angle with the horizontal to make the mixture flow from jar. The heavier or thicker the material, the greater the angle through which the jar must be tilted to make the mix flow out. Let's see how far the jar must be tilted for various mix consistencies.

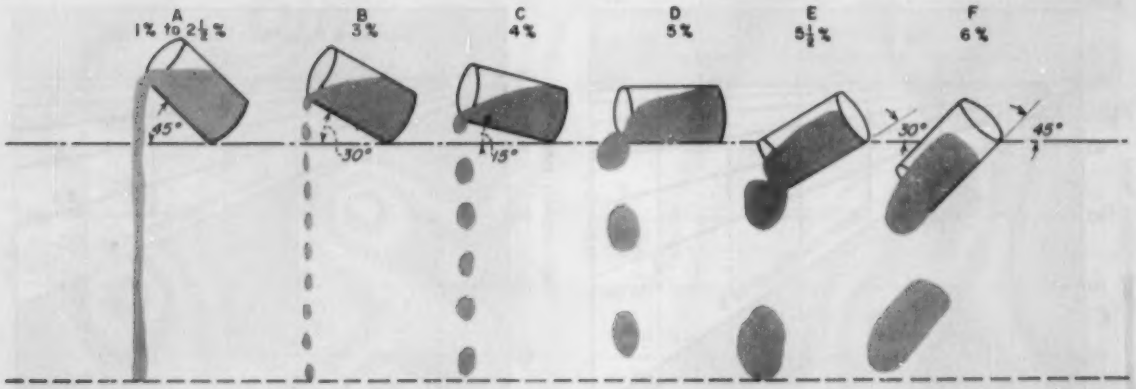
Beteween 1 and 2.5% consistency, Fig. 3*A*, the mix flows in a continuous stream, much like water, when the jar is tilted at an angle of about 45 deg. Surface of the mixture in the jar remains nearly flat.

At 3% consistency, Fig. 3*B*, the jar must be tilted to 30 deg. Flow changes from a solid stream to small, continuous droplets. Surface of mix in jar begins to show a convex shape.

With a mix consistency of 4%, Fig. 3*C*, the angle of tilt is 15 deg. Mix emerges in larger drops and less continuously. Surface is more convex. At 5%, Fig. 3*D*, the jar side is horizontal,







3 Flow characteristics of thick liquids may be visualized as shown here. Note that as stock consistency increases, the resistance to flow becomes greater. Actual liquids may not behave exactly as shown, but closely resemble sketches

for thick liquids and paper stock

mix drops in very large gobs. Surface of mix in jar is quite rounded, and V-shaped cracks appear as mix begins to drop from jar.

With a 5.5% mix, jar must be tilted so its side is about 30 deg below the horizontal. Surface of mix shows large V-shaped cracks as it leaves jar. Entire contents may leave in two or three large gobs. Note how mix removes itself from bottom of jar.

When mix is 6%, jar must be tilted 45 deg below horizontal and the whole mass leaves as one large single body or slug. Entire contents of jar moves as a solid mass or plug.

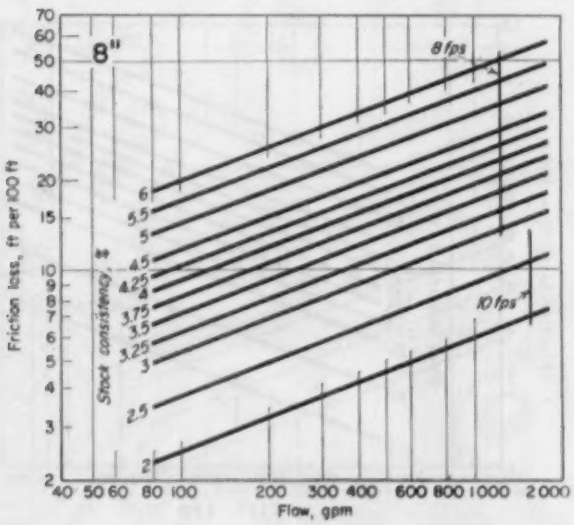
Accuracy. While Fig. 3 may not be exactly correct for the tilt angle in relation to the consistency or behavior of all thick liquids, it can serve as a rough guide in finding the fluidity of many thick mixtures. By observing their flow we can compare them with the thick liquid about which the greatest amount of data has been accumulated—paper stock.

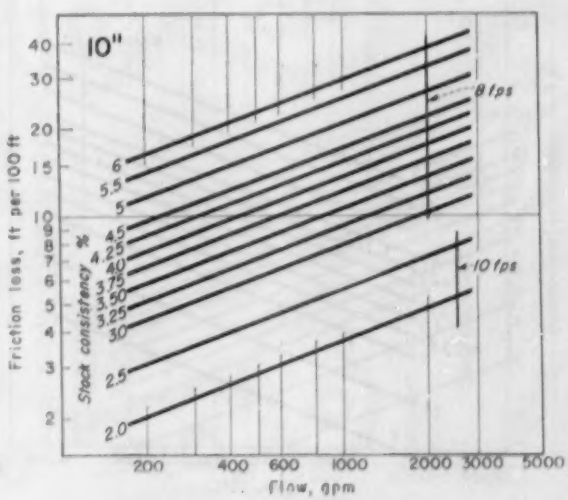
A comparison like this can be a big help in choosing the proper type of pump and impeller for a given job. Fig. 1 and 2 show typical pumps designed to handle paper stock, fruit pulp, mashes and similar thick liquids.

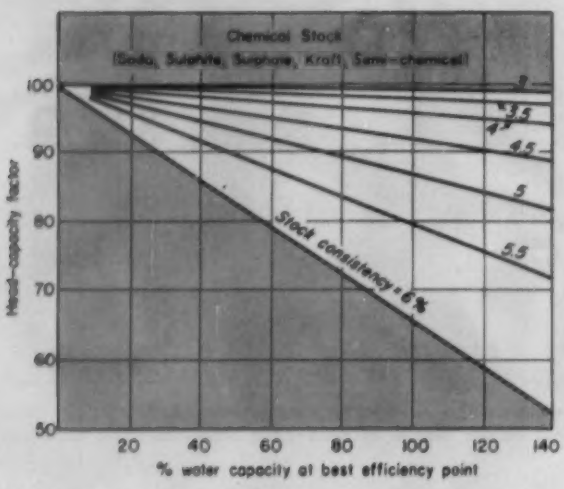
Pointers. When pumping a thick liquid made up of a mixture of a liquid and a solid, the most important consideration is to provide suitable suction head and piping so the material easily reaches the impeller. Here the warped vanes of the impeller can pick it up without unwatering or clogging.

When proper suction flow is secured, remainder of the problem is simple. Almost any centrifugal pump will force the mix into the discharge line. Discharge head is figured in the usual manner, using the resistance found for the consistency being handled.

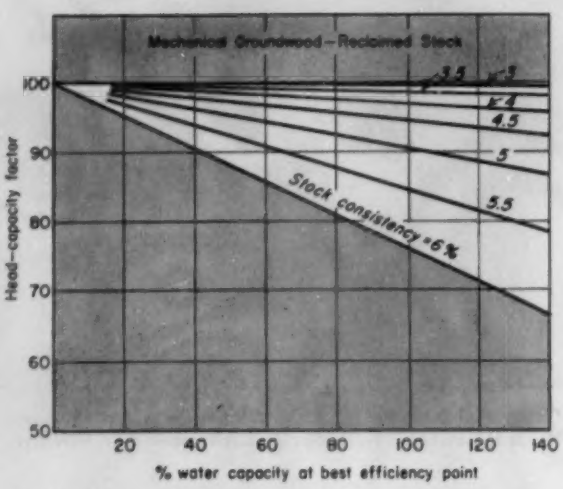
Friction losses. Curves at the bottom






Chemical Stock
(Soda, Sulphite, Sulphate, Kraft, Semi-chemical)
Head-capacity factor
% water capacity at best efficiency point
Stock consistency = 6%

4 Head-capacity correction factors for chemical stock—soda, sulfite, sulfate, kraft and semichemical stocks


Mechanical Groundwood—Reclaimed Stock
Head-capacity factor
% water capacity at best efficiency point
Stock consistency = 6%

5 Head-capacity correction factors for mechanical groundwood and reclaimed stock handled in centrifugal pumps

of these and the two previous pages give the friction loss of paper-stock suspensions of various consistencies in schedule-40 steel pipe. They are based on work done by the University of Maine on the data of Brecht and Heller of the Technical College, Darmstadt, Germany. Published information on 6.34-in. ID spiral welded pipe used in the University of Maine Testing Laboratory shows the magnitude of friction losses is similar to those of the Brecht and Heller data.

The charts may be used for all pipe materials. But friction in cement-asbestos pipe may be lower than the values shown in the charts.

For other types of stock the friction loss, read from the charts, must be corrected by a suitable factor. Suggested factors for a number of different stocks are given below.

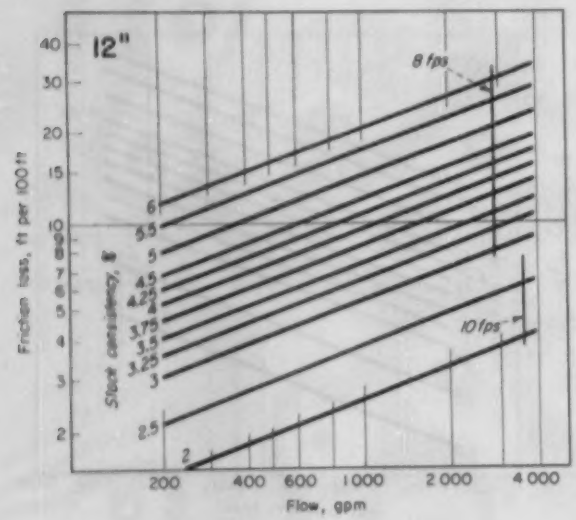
Stock	*Friction-factor multiplier*
Unbleached sulfite, kraft and cooked groundwood	1.00
Soda, sulfate, bleached sulfite and reclaimed paper	0.90
Groundwood	1.40

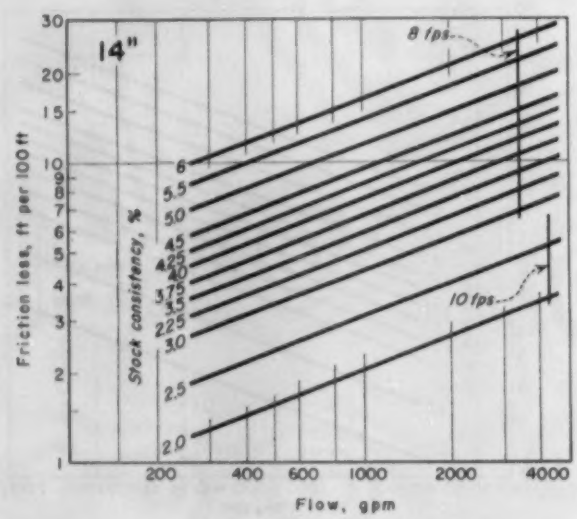
For consistencies below 1.5%, use water friction values. Below a consistency of 3%, the velocity of flow should not exceed 10 ft per sec. For suspensions of 3% and above, the maximum velocity in the pipe should be limited to 8 ft per sec.

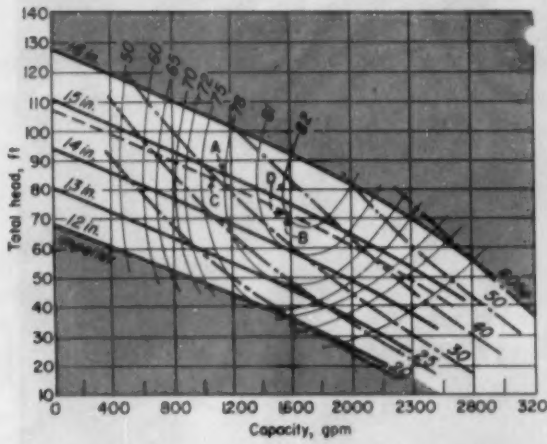
Example: Find the friction loss in 100 ft of 12-in. schedule-40 pipe when 1000 gpm of sulfate stock is flowing. Consistency of the stock is 4.5%.

Solution: Enter the chart for 12-in. schedule-40 pipe at a flow of 1000 gpm and project upward until the 4.5% consistency curve is intersected. At the left, read the loss as 12 ft per 100 ft of pipe. Correcting for sulfate stock, using the value from the table, left, loss per 100 ft = (0.90) (12) = 10.8 ft. Note that these charts may be used for both suction and discharge piping.

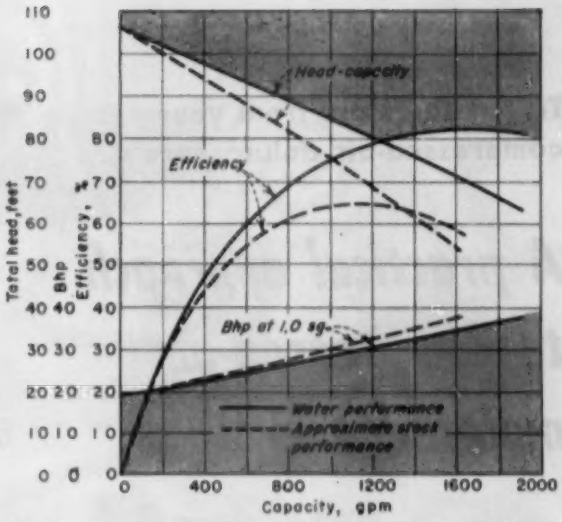
Pump selection. Centrifugal pumps handling paper stock and similar liquids usually develop less head and deliver less capacity than when handling pure water. For this reason it is often necessary to correct the water performance of a pump before its suitability for paper-stock use can be







6 Centrifugal pump characteristics used for determining the stock performance of a unit discussed in the text



7 Water and stock performance of a centrifugal pump found by a series of calculations described in text of article

determined. Fig. 4 and 5 give head and capacity correction factors. Here's an example of their use in a problem.

Example: What capacity and head must a pump develop to deliver 1000 gpm of 5% air-dry kraft stock at 75-ft total head? What do these values mean?

Solution: Enter Fig. 4, the correction chart for chemical stock, at 100% capacity and project upward to the 5% consistency curve. At the left, read the water-rating correction factor as 0.87. Divide the stock head and capacity by the correction factor, or 1000/0.87 = 1150 gpm, and 75/0.87 = 86.2-ft total head.

These values mean that a pump rated for 1150 gpm of water at a total head of 86.2 ft will deliver 1000 gpm of 5% kraft stock at 75-ft total head. Water ratings are used for almost all centrifugal pumps because it is extremely difficult to test pumps for the large number of other liquids they may handle in actual service. Use of a correction factor as shown here is easier, saves time and money.

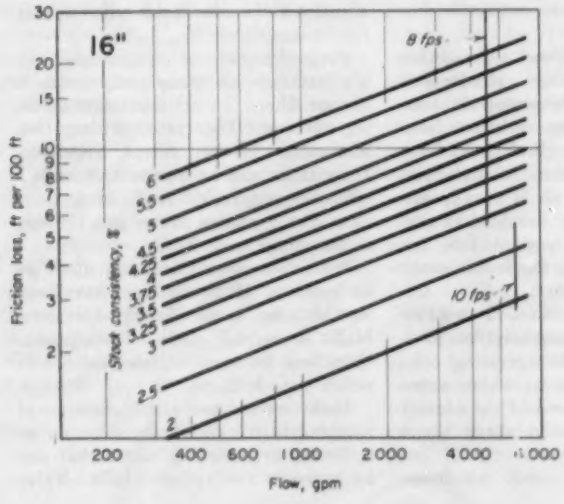
Correction factors in Fig. 4 and 5 are approximate for normally refined stock of 400-600 SR seconds freeness, with short, direct suction lines of ample size. Faster or freer stocks and those with entrained air may require greater corrections. Slow stocks and those containing fillers and additives may require less correction because the stock stays in suspension more readily. But overdosing with additives like alum may cause gas formation on the stock fibers.

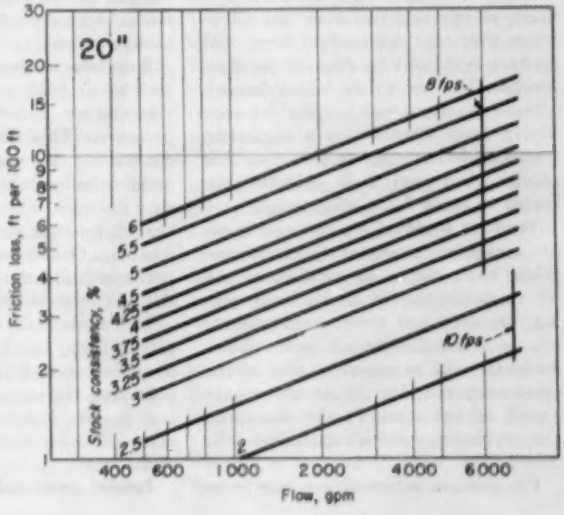
Actual pump. Fig. 6 shows the characteristics of a pump that might be suitable for the conditions given in the above example. To use this curve and secure a sizable power saving, we must try to reduce the impeller diameter from that required for the water conditions to some smaller value. Here's how to do this.

1. Locate the water-rating point *A* at 1150 gpm and 86-ft total head. To deliver this head and capacity, a 15-in.-diameter impeller would be used because point *A* just about falls on the curve for this diameter, Fig. 6.

2. Capacity of this pump at its best efficiency point (bep) *B*, Fig. 6, is 1600 gpm for an impeller of slightly smaller diameter than that for the water rating. Multiply this capac-

(*Continued on page* 208)



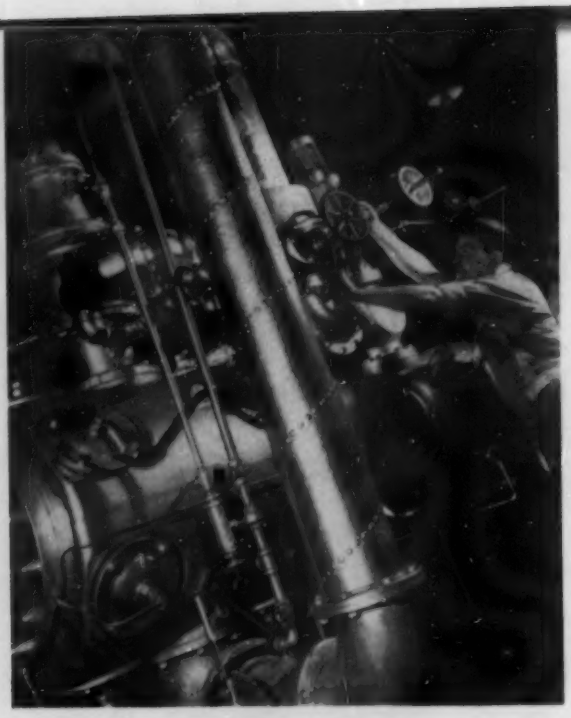


COMPRESSORS

To get the most from your compressed-air dollar, here's . . .

A practical approach to compressed-air maintenance

By J E CUMISKEY, *Assistant Manager*
Compressor Div, Chicago Pneumatic Tool Co



► SURE YOU'RE GETTING the most for your money out of your compressed-air plant? Maybe you are. But if you're in doubt, read on. We're going to talk about some operating and maintenance pointers you've probably heard before —*and* some less apparent items that could be cheating you out of top compressor performance.

Air and water piping need to be planned with these points in mind: Avoid sharp bends in air piping. They boost friction losses. Sloping air lines slightly, away from the compressor, keeps any condensate that may be present from draining back into the compressor cylinder.

Where you can't avoid a piping-system low point be sure to provide a drain so operator can blow out oil or water that may accumulate here. Oil pockets that can't be drained are dangerous. They're an explosion hazard.

Solid supports and bracing for your piping keep vibration to a minimum, prevent misalignment or distortion that results when compressor cylinders are forced to carry full piping weight.

Pressure surges are a common cause of erratic compressor performance. When such surges or oscillations are set up in the suction or discharge piping, capacity and power requirements can be affected. The air pulse shows up as *starving* or *supercharging* of the compressor cylinder. It can also create added backpressure in the discharge line—trimming down operating efficiency.

Fig. 2 shows a typical pressure wave that's causing pulsations in a suction pipe. It's virtually impossible to predict where pulsations will be set up in the piping system. Such pulsations should be checked by the compressor manufacturer. He's in a position to advise you how to avoid them.

Effective intercooling plays a key role in keeping down power consumption of multistage compressors. Perfect intercooling means that air entering second-stage cylinder is cooled to same temperature as air entering the low-pressure cylinder. For every 10 deg F above perfect intercooling, power required climbs about 1%. So for best efficiency, pipe coldest available water for intercoolers. This isn't always true for gas compressors since water that's too cold may condense certain hydrocarbon gases.

Regulate water flow to cylinder jackets to hold average cylinder-wall temperature above incoming-air temperature. This keeps moisture from condensing in the cylinder, washing away cylinder lubricant. In high-pressure cylinder, where air is usually saturated, too-cold water can lead to real trouble. One good way to lick the problem is circulating the jacket water through intercoolers first.

Thermostatically-controlled water valves keep water consumption to a minimum, insure right operating temperatures. In many areas where water is expensive, water saved by the control valve pays for the valve many times over.

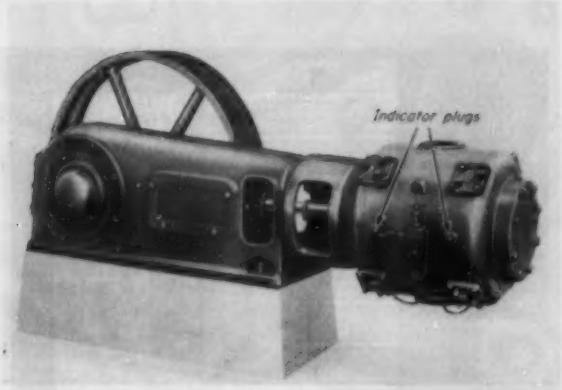
Special materials, such as brass water piping, cupronickel intercooler tubes, etc, are worth their extra cost where you must use salt or brackish water. Muddy water builds up deposits in cylinder jackets. So it pays to keep water clean. And check regularly to make sure that jacket-cooling effectiveness hasn't dropped off because of poor water condition. It's a good idea to flush jackets periodically.

Taking a good look at intake piping, during installation, to make sure it's clean, can spell the difference between good and poor compressor operation. Remove all grit, weld beads, scale or other dirt. Time and effort spent on a thorough scouring job pays off. If these particles aren't removed before startup they are drawn into the cylinder. Their abrasive action scores the cylinder, may ruin it completely.

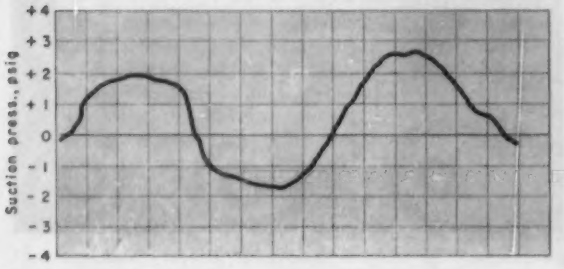
Forgotten piece of equipment—once it's installed—on many compressors is the air filter. To get maximum cleaning effect and keep pressure drop to a minimum, service filters regularly. Dirty units can be at the root of low efficiency, capacity. And, in a short time, dirt in suction stream gets through to the compressor itself.

When compressor acts up, don't go on hunches. Many machines have been wrecked by wrench-happy operators. Make a careful study of symptoms. Then look for some telltale evidence to verify your findings.

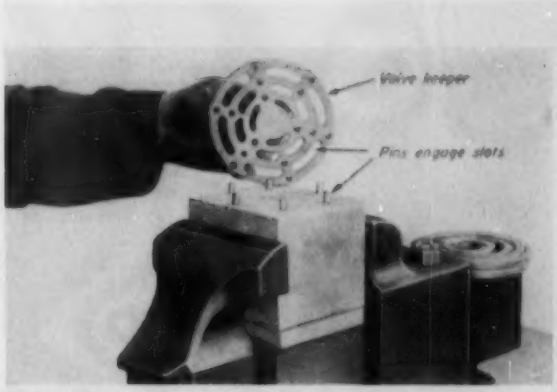
Leaky valves are often a source of trouble. Inlet valve leaks show up as a hissing or whistling sound that can be heard at the cylinder inlet. Valve



1 Discharge-valve leak can be detected by removing indicator plugs after shutting off unit against pressure



2 Air-pressure wave in suction pipe causing pulsations. Such surges are common cause of poor compressor performance



3 First step in using fixture to keep valve in position without allowing vise to mar valve. Pins engage slots

4 Compressor valve is lined up and assembled on fixture. Valve cleaning, maintenance is done with fixture in vise

cover is hot when compared to valves that aren't leaking.

Discharge-valve leak can be detected by removing the cylinder indicator plugs, see Fig. 1, after shutting down the machine against pressure. Leaky exhaust valves cause line pressure to blow back into the cylinder and out the indicator openings.

Intercooler pressure on multistage machines is an excellent guide to compressor's condition. Normal intercooler pressure is on unit's nameplate. If pressure is too high, look for valve or piston-ring leakage in the h-p cylinder. Low pressure shows leakage in the l-p cylinder.

Punctured intercooler tube, if small, causes air bubbles at the water funnel. If hole is big, water spurts.

Compressors, even when in perfect condition, aren't silent. Get to know normal noises. Don't mistake an *air thump* for a knock, loose bearings, or sloppy crossheads. And don't be tempted to adjust the running machine if a knock does develop. Shut the unit down and check all running clearances carefully. Check oil for dirt and right level. Be sure all lubricated parts are receiving oil. If these items check out OK and knock persists, it's time to call in the manufacturer. He'll take needed steps to get the machine back in service with minimum delay.

Compressor valves need to be inspected at regular intervals. Time between inspections naturally varies with operating conditions. It's good practice to keep several complete valves on hand, using them to replace those taken out of the machine for cleaning and repair. Next set of valves needing overhaul can then be replaced by reconditioned valves. And there's no need to keep a complete set of spare valves. Down-time is reduced, while valves removed from the machine can be carefully reconditioned at your own convenience.

Fixture, Fig. 3, simplifies valve repair. Fixture keeps valve in position without allowing vise to mar its surfaces.

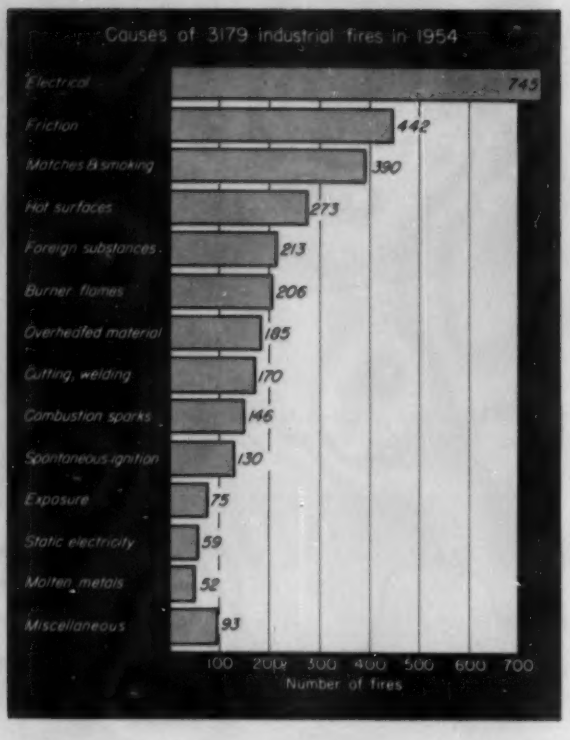
Important point: Don't kill your valves with kindness. Limit lube oil fed to the cylinder to the drops-per-minute recommendation on the manufacturer's nameplate. Too often operators increase oil feed above recommended flow. Result: Increased carbonization, more leaky valves and more maintenance—boosting cost of compressed air.

Unattended compressors should be protected with safety shutdown devices. High-temperature cutout switches for discharge air, water and bearings give needed protection. If water supply is subject to outages, install a low-water-pressure shutdown or alarm device.

Caution: Don't let protective devices lull you into a false sense of security. They're not a substitute for regular maintenance and inspection schedules. They *can* protect your investment. But they *can't* do the impossible—save equipment that's poorly installed and maintained.

Best way to keep track of your compressor's health is with an hourly log, listing (1) intake-air temperature (2) intercooler-air and discharge-air pressures (3) cooling-water inlet and outlet temperatures (4) ammeter and voltmeter readings (5) accurate count of operating hours.

Armed with a complete log of your compressor's performance, it's a simple matter to set up routine inspection and maintenance procedures. In the long run you'll find that compressor care pays off to the tune of higher efficiency, fewer outages and minimum repair.



When you know how fires start . . .

You can cut down plant fire loss

► How did it start? This is the natural question when any fire breaks out. The chart above gives causes of 3179 industrial fires last year, in plants insured by Associated Factory Mutual Fire Insurance Companies.

Note that 745 fires (23.4% of the total) resulted from electrical causes. Electric equipment was improperly installed, poorly maintained or worn. Or electric devices or fittings were types unsafe for areas involving flammable vapors or dusts. Arcing or overheating started other fires.

And 442 fires (13.9% of the total) were caused by friction from hot bearings, misaligned or broken machine parts, material choking or jamming in machines, improper adjustment of moving machinery. Blazes started by grinding and sanding operations are included.

Matches and smoking caused 390 fires (12.3%). This includes careless use of matches, careless disposal of lighted cigarettes.

Eliminating these three causes alone might have prevented almost 50% of the 3179 fires.

Yet there is more to the problem than merely eliminating sources of ignition. Keeping a plant fire-safe is a twofold problem involving (1) preventing fire causes (2) controlling and extinguishing fires after they start.

In preventing fires, there are only two types of precautions to consider: eliminating (1) ignition source (2) fuel available at the immediate ignition source. (See Power, Oct 1954, p 132, for 28 specific ways to prevent fire.)

There are many sources of ignition. A great number of them might have been eliminated by better maintenance procedures, better equipment design, employe education.

Much of the fuel that helps the fire spread from the initial ignition point might be removed by good housekeeping practice. Oily deposits on machinery, combustible wastes and rubbish can be eliminated. Combustibles in the vicinity of cutting or welding operations can be moved or covered; and flammable vapors can be vented before they reach ignition sources. These precautions are obvious, yet often overlooked.

Many commonly used materials require particular safeguards because they are subject to spontaneous heating and are both ignition source and fuel.

Controlling fires. In controlling and extinguishing fires, much of the emphasis in preventing losses is placed on the type of construction, arrangement of the occupancy, and the fire protective equipment. This helps assure that, if a fire does start, it will not cause much damage. This approach requires careful planning in advance, is less influenced by the human element, and gives more positive results than could be obtained by merely seeking to eliminate sources of ignition.

Fire-prevention rules. But actually, the great majority of fires need not start at all. Basic rules are simple:

1. Prevent accidental sources of ignition by avoiding careless practices and correcting unsafe conditions.

2. Practice good housekeeping so there will be no fuel available for "accidental" sources of ignition.

3. Where flame or hot surfaces are inherent in processes, maintain safe control and keep combustibles away except as required by process.

New jeep-mounted fire truck guards in-plant areas

► A CONCEPT of fast defense against industrial fires provides inspiration for a new jeep-mounted fire truck (right). The unit is only 60 in. wide and 132 in. long. It can travel through aisles inside the plant, carrying a variety of extinguishing agents direct to the scene of the fire.

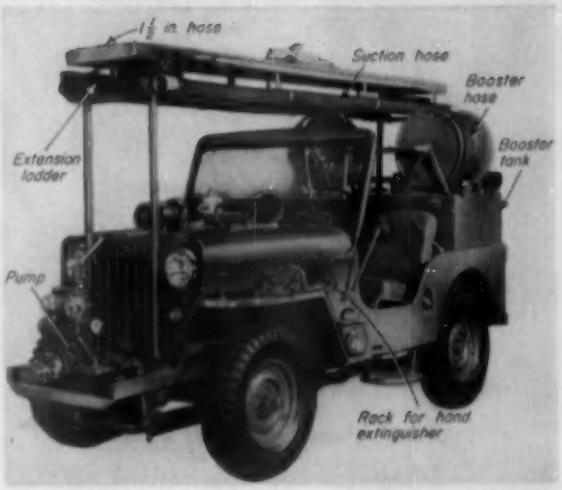
This new truck helps plant firemen fill the gap between fires that portable hand extinguishers can control, and those requiring aid of municipal apparatus. It is more mobile than hand- or battery-powered fire carts, and carries more equipment. Thus, men can get at the fire faster, with more fighting power.

The truck is custom built to suit plant requirements. Unit pictured was built for the Curtiss-Wright Corp plant at Woodridge, N. J. It carries (1) 350-gpm pump (2) booster tank holding 100 gallons of water that will supply six minutes of fog spray (3) 100 lb of CO_2 with 50 ft of hose (4) 104 lb of dry chemical in portable extinguishers (5) 150 ft of 1½-in. hose (6) two 10-ft lengths of hard suction hose (7) 20-ft extension ladder (8) assorted rescue tools.

Produced by Sentry Safety Service in New York, N. Y., and known as the *Minitruc*, the unit has 4-wheel drive. It can be driven down plant aisles or lifted by freight elevator. Standard-size wheels permit crossing hose lines, assembly line tracks, etc, and traveling from one building to another.

The 350-gpm pump can provide 300 psi for straight stream or high-pressure fog to fight stubborn blazes. The 100-gal booster tank with 100 ft of hose provides an instantaneous water supply for initial knock-down or cover while hose and suction lines are hooked in.

Another advantage is that skilled firefighters need not act as errand boys to fetch equipment from across the plant. Foam playpipe, smoke mask, wrenches, emergency light, ladder, ax, rescue tools are all carried on the vehicle.



TRUCK'S firefighting equipment meets individual plant needs

WEARING his gas mask would have endangered electrician's life

Which is more important: safety or regulations?

► SOMETIMES you have to break the rules in the book to be safe. Here's a case in point:

During World War II, I was post electrician at an Army air field. There were frequent gas alerts; all military personnel had to wear gas masks while continuing normal duties. This slowed work, but normally caused no trouble.

One time, the primary fuses on a bank of large 7200-volt transformers went out about the time the gas alert sounded. Power from these transformers operated important machines in one of the hangars. Operations stopped dead.

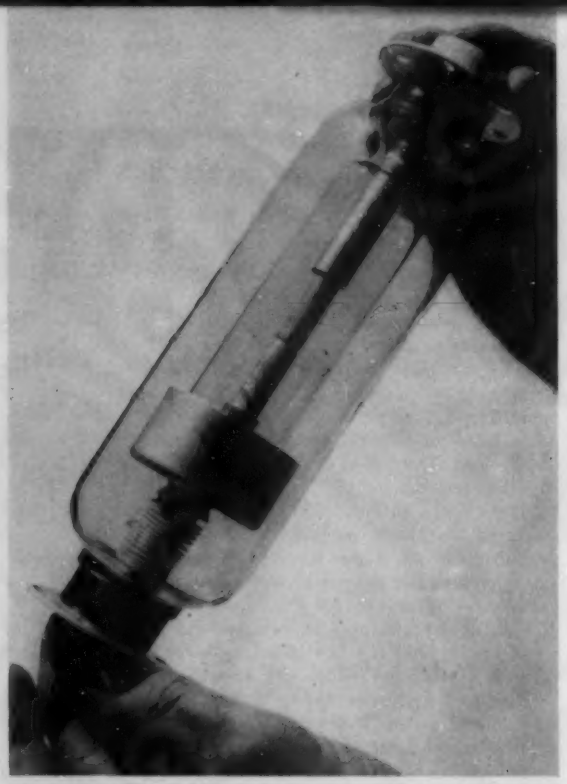
My chief electrician was a staff sergeant, subject to the gas-mask regulation. He and I went out to get power going again and he climbed the pole wearing his mask. Working space near the fuse boxes was scarce and poorly arranged, and the mask made seeing difficult. Being afraid he would get hurt or killed, I told him to take off the mask.

Within minutes Military Police arrived. I insisted that the work had to be done and could not be done wearing a mask. The MP held that the mask had to be worn. There was some rough talk, but the MP had no authority to shoot and could not climb the pole, so the sergeant finished the job.

When he came down we had to go to MP headquarters. I finally demanded to see the colonel in command of the field. When he heard how dangerous it would have been for the electrician to keep the mask on, the MPs had to drop the matter and set us free.

E A ROBERTS *Carlsbad, New Mex.*

Vacuum switches are toddling into the power picture for both low- and high-voltage applications. If they prove out, you can expect smaller, long-lived switchgear, needing little or no maintenance



VACUUM SWITCH is 8 in. long, 3 in. diameter. Glass envelope fused to metal end-caps. The upper electrode is stationary

Will today's vacuum switch become

► As a result of a series of successful field tests, power men in the years ahead will be keeping a close watch on vacuum switch developments while weighing the practicality of adopting such switches for in-plant use. These small glass-enclosed vacuum power switches are an outgrowth of interrupters made for switching high-voltage electronic circuits.

In an article first appearing in *Electrical West*, a McGraw-Hill publication, Jennings Radio Mfg Corp of San Jose, Calif., was linked with Schwager-Wood Corp, Portland, Ore., as developers of vacuum switches for power applications.

What they are. Principle of the vacuum switch is not new. Some 30 years ago, Dr R W Sorensen of California Institute of Technology showed vacuum switches held great promise in the power field. Big problem then, and for many years since, has been holding a high vacuum. Device now being tested is about 8 in. long, 3 in. diameter. Glass envelope is fused to metal end-caps. Upper electrode is stationary, lower is actuated through metallic bellows.

In a paper delivered before a symposium at the Oklahoma Institute of Technology, H C Ross, an engineer with Jennings, pointed out that with today's vacuum techniques, more than five million volts per inch dielectric strength can be attained. Not only does a high vacuum insure higher dielectric strength, but fringe benefits come, too: better contact life, lower contact resistance and faster current interruption.

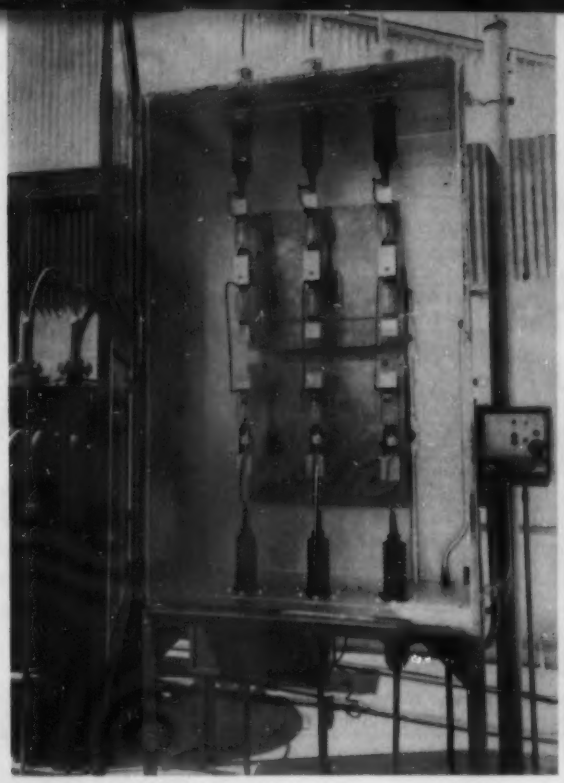
Because of rapid oxidation and contamination, high-temperature metals like tungsten and molybdenum have not been satisfactory as contacts in air. However, under permanent vacuum, contact surfaces of tungsten and molybdenum stay free of surface contaminants to the point where two closed contacts create practically a solid conductor electrically. These metals are among the best contact materials.

Lab tests show a sealed vacuum switch can operate over a million times at about 10 amp at high voltages. Currents between 10 and 100 amp can be interrupted several hundred thousand times. Currents of 10,000 amp have been interrupted successfully over a hundred times.

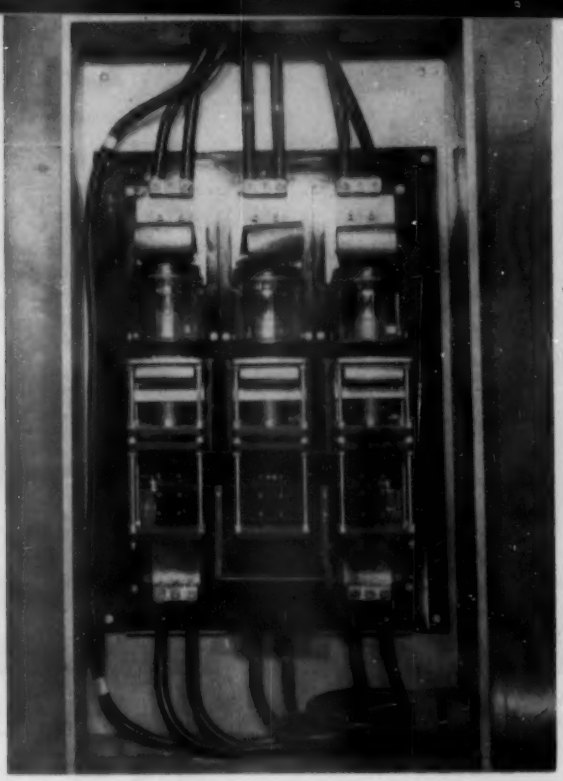
Most contacts operating in air must face the possibility of contact welding when closing on high-charging currents of capacitors, transformers, inductors and tungsten lamps. Welding rarely occurs in vacuum, even with extremely high make-currents.

When interrupting an ac circuit, the vacuum switch deionizes arc at, or before, the first current zero with no restrikes. This means ½-cycle power interruption in a 60-cycle circuit. With the short movement required, contacts can be easily timed to open after first current peak and just before current zero. In this setup, only slight arcing occurs even under heaviest overloads.

Field tests were run in the Jennings' plant on switches in the 12-kv 3-phase plant service. Also, switching and overcurrent protection on all 230-v feeders in the plant is provided by vacuum switches, facing page. The 12-kv entrance vacuum switch has been in constant use for the past two years. Nine vacuum switches shown can be operated manually or by 6-v dc solenoids concealed behind mounting panel. Three switches in bottom row of 12-kv gear serve as 3-phase instantaneous overload protectors capable of ½-cycle interruption. They are tripped by a low-inductance series-trip solenoid in the high-voltage lead and are reset manually or by a 6-v dc operating



12-KV MAIN SWITCH for plant uses three sets of 3-phase vacuum switches as overloads, disconnects and grounding relays



230-V SECONDARY FEEDERS are protected by experimental heavy-duty switches having 1-in.-diameter tungsten contacts

tomorrow's breaker?

mechanism. These switches were called upon several times to interrupt plant fault currents before the 230-v vacuum switches were installed.

Other six switches on the 12-kv panel are mounted in a 3-phase single-pole double-throw arrangement, serving as disconnects and automatic grounding switch. For two years, the 12-kv power line has been separated from direct contact to ground by contacts in vacuum spaced only ⅛ in. apart.

All 230-v plant feeders are protected with vacuum switches having a continuous current rating of 800 amp. Loads include motors, ovens, furnaces, induction heating and high-voltage processing equipment. Switches are instantaneous trip, manually reset, capable of ½-cycle operation. Same type vacuum-switch circuit breaker provides overcurrent protection for the high-voltage test lab. Here, 5000 kva of 60-kv capacitor banks are switched. Tests run regularly on all 200-kva 7800-v capacitor banks check life expectancy of 10,000 operations. Every fault occurring in laboratory has been interrupted successfully by vacuum switches without tripping main 12-kv vacuum switch. Both the main and the feeder vacuum interrupters are set to trip in less than one cycle.

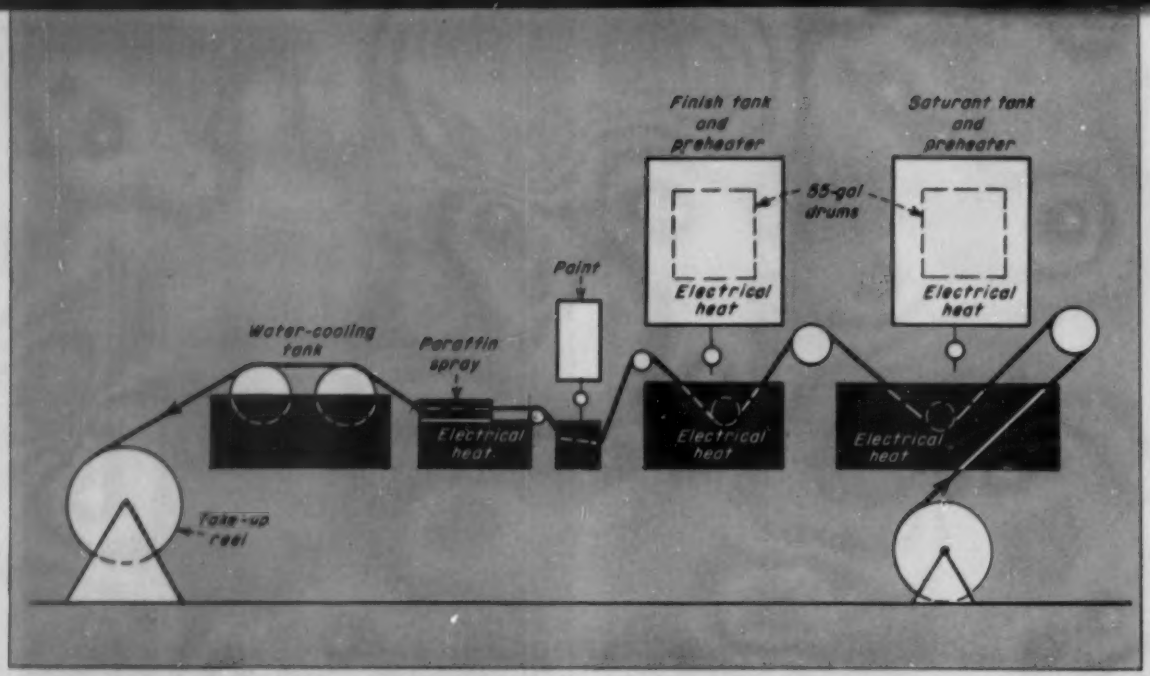
Smaller vacuum switches have been in constant use within the plant for several years, breaking 240-v 60-cycle loads. One such application is on a resistance furnace drawing 80 amp. Here heating elements are pulsed every 18 sec to prevent overshooting. Other applications include a spot-welder control with a make-current of 100 amp.

Radio background. These power switches, with their contacts sealed in a high vacuum, stem directly from the development of vacuum relays for switching dc and 60-cycle currents, as well as radio-frequency signals, commonly found in radio transmitters. In Jennings' plant, small vacuum relays are used for individual protection of mercury-vapor rectifier tubes against overload and inversion. They handle 12 kv at 2- to 20-amp dc. Single-pole double-throw types are installed on vacuum furnaces as combination dc overload and automatic grounding switches tripping each time gas ionization occurs. They are also used extensively in high-v dc circuits of test transmitters.

Vacuum switch has been used by several manufacturers in heavy electronic equipment. They include General Electric, Westinghouse, RCA and others. Switches also have seen service in military equipment. In 1954, A C Schwager of Schwager-Wood joined with Jennings in making field tests on transmission lines. First such test was run last fall on the lines of California Oregon Power Co. A 100-mile 115-kv line was successfully dropped with three switches in series per phase. In the spring of this year, concurrent tests were made at the Schwager-Wood plant in Portland and at the Los Angeles Dept of Water & Power. For latter, capacity or banks formed load. At Portland, tests were run with a single vacuum switch opening 250 amp at 20 kv.

What's ahead? Transmission engineers, observing the field tests, hold high hopes for the future of such switches in the power field. W B Loper, chief electrical engineer for California Electric Power Co, went as far as predicting eventual replacement of oil circuit breakers with vacuum switches, making the former obsolete.

Following the development-pattern of mercury-arc rectifiers, which must also operate in a high vacuum, it is feasible that tomorrow will see vacuum switches available in steel rather than glass enclosures. Metal presents one major advantage if the switches find their way eventually into industrial plants: Hazard of breakage, hence loss of vacuum, would be eliminated.



WIRE-COATING SETUP after swing from gas to electrical heat. Nonmetallic sheathed cable, *far right*, passes through two asphalt compound tanks, heated to 325 F. Coating of aluminum lacquer and hot paraffin spray, next. Cooling is last step

Past 20 years have seen electrical heating loads increase fivefold

- **When all costs are figured, electrical process heat can show dollar savings**
- **Lower product-maintenance costs stem from even heat distribution, fine control**

Electrical heat cuts operating cost in growing number of process loads

► INDUSTRIAL PLANTS are taking a hard look at electrical heat for process and in a growing number of cases give it the green light. Electrical heat has carved some sizable advantages for itself along with a few drawbacks.

Plus side of the picture was clearly stated by J H Ahrens, Industrial Manager of The Hartford Electric Light Co, in a talk before the National Industrial Heating Conference (Jan 1954, Cincinnati, Ohio). Ahrens feels the real essentials for proper heating of any process are summed up in (1) uniform temperatures and their control (2) uniform results. Naturally, industrial applications require economical conversion of any heat source to usable heat. Of course, with the above parameters, electrical heating shines.

Drawback in many engineers' minds, when they look at electrical heat for process, is the energy cost. Too often a potential user makes but a superficial check on comparative fuel costs only, overlooking entirely the more important aspect: unit cost of finished product. The electrical-power bill is but one of the many factors in juggling feasibility of electrical heating and, according to Ahrens, "only a small percent of the over-all cost." Point is that a straight cents-per-Btu comparison with other heat sources often rules out electrical heat. However, the "fringe" benefits of heating electrically often outweigh the cents-per-Btu consideration.

What are some of these side advantages? Well, labor saving possible through automatic control would be one. Flexibility in adapting to hard-to-get-at places, reduced maintenance, lower first cost are other key factors.

Case in point, illustrating what can be done with electrical heat in a small plant, may be found in the Alphaduct Wire and Cable Co, Milltown, N. J. Here a continuous process, see sketch, was converted from gas heat to electrical. Glass-fiber-insulated nonmetallic sheathed cable passes through a long tank containing an asphalt-wax-type saturant heated to 325 F. Then cable goes to a finishing tank housing another asphalt compound, also heated to 325 F. After leaving second tank, cable is immersed in an aluminum lacquer. This operation requires no heat. The next tank houses hot paraffin, sprayed on cable. To set paraffin, cable passes over two water-immersed drums and is then fed to take up reels.

Proven tips for putting electrical heat to work

Heating calculations: Consider heat-up energy separate from energy required to maintain operating temperature. Heat-up energy is heat absorbed by tank or machine, including contents, plus radiation losses during heating-up period. Energy needed to maintain operating temperature consists of heat losses, plus heat going into the liquid.

Corrosion a factor? Then consider a metal sheath other than steel (usual for oil and low-temperature gases) or copper (often used for water). Corrosion-resistant sheaths include stainless steel of the 300 series, monel, inconel, chemically pure lead, nickel silver, nickel-plated steel and many others.

High pressures, say about 2000 psi, and temperatures of about 1000 F are not uncommon in some processes. With direct-immersion heaters, all you need do is provide extra-heavy mounting flanges and take extra precautions in welding. Where heat can be applied outside pressure vessel, consider strip or ring heaters strapped to vessel. Also, strip heaters, clamped to outside of vessel, permit a zone-heating setup to match varying content levels within.

Zone heating, through thermostatically controlled heater groups, provides uniform heating regardless of material level in container. Glue and silica gel are examples of difficult materials to heat direct.

Slow heat is the rule in heating materials with poor heat-transfer properties. Heat must be applied with caution to prevent local overheating, leading to possible carbonization of organic materials. Usual solution: Provide uniform source of controlled heat over container's entire area. Metal-sheathed strip heater with its broad, flat surface is well-suited for clamping directly to sides of process tank being heated.

Both saturant and finishing tanks are really preheating tanks. They are designed so 55-gallon drums of compound can be hoisted, then up-ended into top section of tank. Heat at this point allows contents to drop into tank's lower area. Latter section, also heated, serves as a compound reservoir. Heated valves draw off material as needed in the coating tanks.

Electrical setup finally adopted was worked out by Vito DiPalo of M B Rosevear Co in Bloomfield, N. J., representing Edwin L Wiegand Co. He came up with low-watt density, stock strip heaters, clamped direct to tanks' sides. Heater sizes installed: Saturant preheater tank, both top and bottom, 25 kw; finish preheater tank, top and bottom, 25 kw; saturant-coating tank in two banks, 27 kw; finish-coating tank, 9 kw; paraffin-spray tanks, 3 kw. An additional 2 kw heats the valves of preheater tanks.

Heaters were clamped in position with standard clamps using a Nelson stud welder. Air space of 1 in. was allowed over heaters and a 2-in. metalclad insulation covers tank's exterior surface. After two years' operation there has been no occasion to remove coked asphalt, apparently a rather common occurrence with the old gas-fired tanks. Even the power bill proved a pleasant feature of this job. About $35 monthly was shaved from it by converting from gas to electrical heating.

Applications of metal-sheathed enclosed-type resistance heaters are varied, involving many different temperatures and materials (POWER, April 1955, pp 130-131). Heaters of different watt-intensities should be used depending on application. Example: A large quantity of heat can be concentrated in a small unit to heat water, or dilute water solutions of chemicals, since water is a good heat transfer medium. This is particularly true with open-tank heating or kettles vented at atmospheric pressure since water or solution temperatures will not greatly exceed 212 F. By contrast, when heating a modern heat-transfer fluid, temperatures may reach 600 F. Here, immersion-heater rating should be reduced by about half that for water.

Common denominator for metal-sheathed resistance heaters is *heater watt-density.* This is the factor governing heater temperature. Watt-density figure is equal to heater rating in watts, divided by heating area in square inches. Following are typical materials, along with their normal operating temperatures and recommended allowable watt-densities:

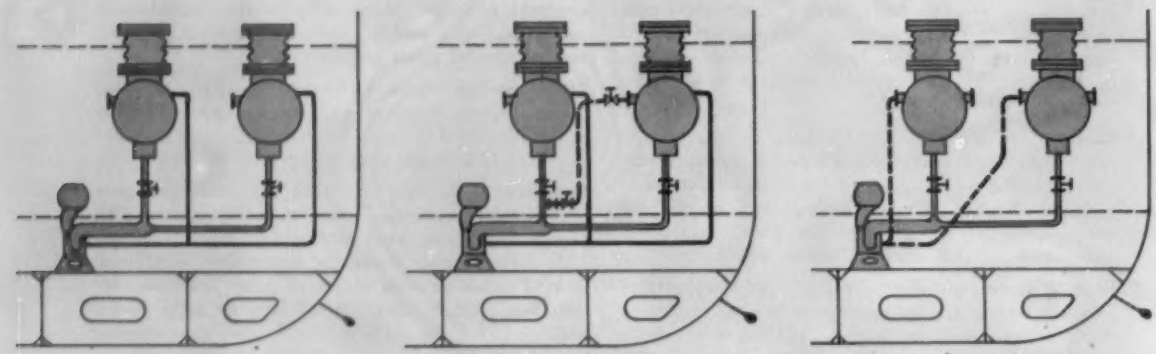
Practical values for heater watt-densities

Material heated	*Temp F, approx*	*Watt-density*
Water	212	45
Prestone	300	25
Dowtherm "A"	650	20
Bunker-C fuel oil	160	10
Molasses, asphalt	100	4

Note that as materials become more viscous, allowable heat intensities must be lowered. Surface temperature of an inversion heater in water is essentially the same as water temperature. Yet the same heater in a thermoplastic resin is 300 F higher than resin temperature. This might lead to problems. Take a resin that decomposes at 500 F. Desirable process temperature may well be 300 F. You could easily run into trouble here if a high watt-density water-type immersion heater were used since it would operate at 600 F. In time, the resin would decompose. Best solutions are: (1) Decrease watt-density of heaters. (2) Clamp strip heaters to outer side of container, thereby using entire container area as a heating surface.

Pipe heating is another application getting much attention from an electrical-heating angle. Typical installation involves liquid moving from one location to another. Fluid's temperature must be maintained, compensating for heat loss along pipe to insure proper fluid flow. Normally, all that's needed here is to offset heat loss, hence heating capacity may be calculated from surface area and heat loss through insulation. Heater units may be strip heaters curved to fit pipe contour, or cable elements designed specifically for pipe heating. Where maximum pipe temperatures stay within 275 F, plastic-covered heating cable is often used. Such cable is easy to install, particularly around irregular bends, fittings, valves. By insulating pipe and installing a thermostat, the installation is permanent.

Latest PRACTICAL IDEAS to help you keep



What's best way to vent ship's auxiliary condensers?

TROUBLE . . . Lying alongside the dock, our outboard auxiliary condenser filled with water, lost vacuum steadily. I started the main condensate pump and lined up crossover connections, but no soap. Second engineer, old-timer on ship, started inboard auxiliary unit. With vacuum up on inboard unit, he opened the inboard condenser's condensate valve to the common suction line. That brought the water level and vacuum back to normal in our outboard condenser, first sketch.

I soon learned that a starboard list gave us trouble, especially when the outboard auxiliary unit was used. (Auxiliary unit is used only in port as main condenser handles all auxiliaries at sea.) All vent lines, valves and condensate suction valves had been inspected. But no trouble was found in system.

My solution is to install a small vent line with check valve and stop valves from outlet side of inboard suction valve to blanked flange at top of outboard condenser, sketch. This will remove air trapped in enlarged portion of condensate pump's suction line when vessel is listed to starboard.

Since we keep up with Marmaduke Surfaceblow, that greatest of all living power engineers, won't you kindly ask him to put down his bottle long enough to give us some sage advice?

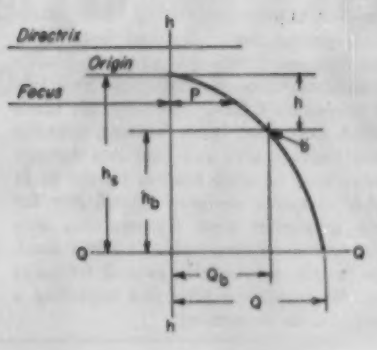
C A BUTTERWORTH
Houston, Texas

Surfaceblow's answer: BILGEWATER on trick condensate hookups. Sure, if your front door's locked, you can get upstairs with a ladder and crawl through a window. But why not do it the easy way and unlock the front door instead?

Tell Butterworth all his Chief has to do is tear out the vent lines from his condensate pumps and hook them up as in my sketch. The way some crazy mixed-up shipyard hooked up his vents, the horizontal parts get water-logged every time his ship takes a starboard list. They probably used shore-side pipe fitters. Vent lines must be as near vertical from the condensate pump to condensers as possible. This holds true ashore or at sea. Then his ship, rolling or taking a list, won't affect vacuum. I've straightened out dozens of those vents during the war—what in hell's wrong with our shipyards?

MARMADUKE SURFACEBLOW
Bent Propeller Bar

In a pinch use this head-capacity curve for pumps



MOST ENGINEERS have use for centrifugal-pump head-capacity characteristic-curves at times, but cannot find data on them. Information here was obtained from both mathematical and pump texts. While it's approximate, it has served my purpose very well.

1. Shut off head of pump in feet or psi for specific pump.

2. Head in feet or psi and capacity in gpm for pump at one point of operation on the curve.

Procedure: Curve equation is $Q^2 = 2\,Ph$ when Q = gpm and $2P = \frac{Q^2}{h}$

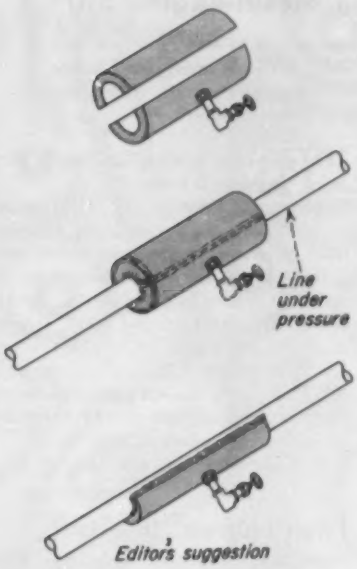
h = head ft or psi, that is, $h_s - h_b$
$2P$ = latus rectum of parabola
Q_b = gpm at operating point on curve
h_b = head at operating point on curve
h_s = shutoff head of specific pump

Example: Assume shutoff head h_s to be 90 psi; head h_b and capacity Q_b at point b on curve to be 60 psi and 45 gpm, respectively. Now $Q^2 = 2\,Ph$ and $2P = Q^2$; therefore, $2P = \frac{45^2}{30} = 67.5$ and $Q_x = \sqrt{67.5\,h}$ at any point on head-capacity curve h of this specific pump.

P W WHITE *Newport, R. I.*

production going at top speed

STEVE ELONKA, *Associate Editor*



You *can* repair a leak on live steam line

TO REPAIR a leak in live steam line, I weld a piece of sleeve over it. Sleeve is about 18 in. long and two diameters larger than leaky pipe, sketch. First, I cut larger pipe in half. Then, I electric-weld some 3/8-in.-thick sheet-iron pieces to ends.

First, weld top half of sleeve to pipe. Then, weld bottom half and leave valve shown open, so steam pressure is relieved. When welding is complete, close valve and insulate. I have used this method on 150 psi at 550 F.

D W ANTONACCI *Bolivar, Pa.*

EDITOR'S NOTE: Why not prepare a blister as in my sketch? Have this fit leaky pipe. When you are satisfied that it fits as it should, clamp onto leaky section with C clamps. Then weld it on and close valve when finished. Reason I suggest this method is that it calls for only half the work. Any ideas or experiences from you readers?

Magnet holds light

WHEN WORKING with a temporary light, where surrounding surfaces are smooth so you can't support the light, hold by fixing a small permanent magnet to the lamp base. Clean paint off smooth metal and let magnet hold light to smooth surface. Magnets are handy.

W E WARNER
Woodford Green, Eng.

Here's your 'trick' of the month

THE YARD GANG used an outside shed to change and hang up their clothes. Later, the superintendent had a lavatory installed so the men could wash. This was a convenience, but during cold weather the hot- and cold-water lines would freeze because the shed had no heat.

Shutting off the water and draining lines was not the answer. Reason was that the lavatory was used only a few times a week. Water would be turned on then, but was often forgotten. Insulating the pipes wasn't the answer either as it merely delayed but did not stop freezing.

Our electrician solved the problem very simply. He had the carpenter build a small cupboard around the pipes. Interior was lined with a layer of roofing paper and about 1½ in. of fiber-glass insulation. Electrician then fastened a couple of lamp sockets inside the insulated space and put two 25-watt lamps inside.

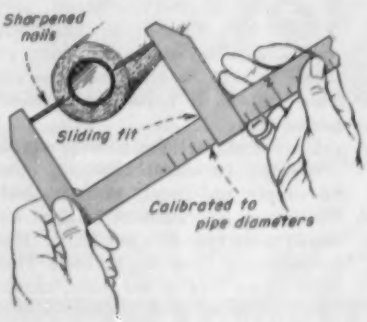
Next, he installed an old heat-control thermostat of the common wall type, also a relay that would snap the two 25-watt lamps on as soon as the temperature fell to the thermostat's setting. He set the thermostat to switch on the lamps as soon as temperature fell below 40 F. This solved the problem very nicely.

As soon as space under the lavatory cooled down to 40 F, on came the lamps to heat the space up to about 45 F. Then lamps cut off again. Use of two 25-watt lamps instead of one 50-watt lamp was a safety precaution. If one lamp burned out, the other still gave enough heat to protect water pipes. At regular monthly inspection of all lamps, a burned-out lamp would be discovered and replaced.

Everything was inside the small cupboard, door was padlocked to open to electrician's master key. Water splashing on cupboard did no harm for roofing paper kept interior dry. Faucets above basin didn't freeze because as soon as water cooled to 40 F (maximum density), it would sink in the pipe. There it was replaced with warmer water, and thus didn't freeze.

No freezing trouble after installing cabinet. Idea has many applications.

G P PEARCE *Albuquerque, N. M.*



"X-ray" calipers

I USED CALIPER shown to check line sizes of insulated steam and condensate piping when making "as-built" drawings.

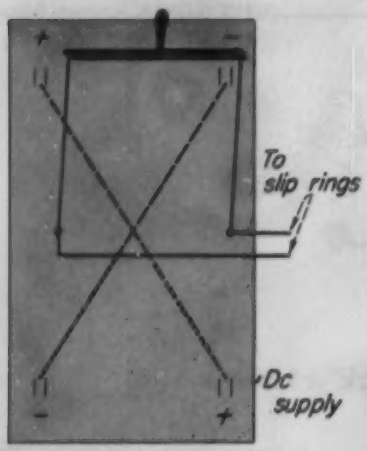
The insulation used was not uniform and we had, along with other sizes, 2½ and 1¼-in. pipe. But I was able to measure these sizes easily and without damaging expensive insulation.

M F BROWN *Sausalito, Calif.*

(*Continued on page* 138)

More PRACTICAL IDEAS

Begins on page 136



Why not neutralize?

I NOTE a reader had trouble with an old, old offender—insufficient brush contact area on slip rings.

We had that trouble away back when Hector was a pup, but it was a 600-hp synchronous-motor drive to a compressor. We just got awfully tired of having a shutdown when least expected, from excitation loss. We added another brush holder, giving one more brush per ring. It was an all-day job for an electrician and millwright. It wasn't complicated as designer anticipated eventual need for more contact area by brush. We changed brush type too.

But that is another story. We were the unhappy victims of slip-ring polarization. That caused positive ring to become progressively darker with time. Weekly "holy stoning" and crocus-cloth polishing kept our compressor "cooking." We had a trick up our sleeve. We installed a double-pole double-throw switch in the inside of the railing guarding the wheel pit. Log requires the operators to throw the switch over every Monday morning. Result: complete neutralizing of vexing polarizing effect by reversing excitation current.

P C ZIEMKE *Oak Ridge, Tenn.*

Need beer money?

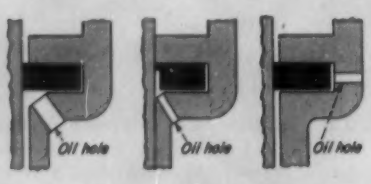
DID YOU EVER get a check from POWER? It's easy. Just send me your latest practical improvements. Add sketches, photos, or both. You'll receive a check for each idea I accept. Some readers get a check every month.—*Steve Elonka*

Look—more ideas on diesel-engine oil!

EDITOR'S NOTE: Yes, here is more dope on how to save diesel oil with scraper rings. Also on how much lube a diesel needs for efficient operation without wearing cylinder liners excessively. Does this wind up the discussion, or have you a different slant?

Here's my answer . . .

I'LL GO ALONG with Camacho, March, p 137: Drill holes in scraper ring grooves to increase efficiency. My sketch



shows three methods of drilling piston. But number of holes drilled is another thing. Too many holes weaken the skirt. If drilled holes become clogged with dirt, that also is a problem.

Remedy: use clean oil. When piston moves up, rings move down. Oil trapped by first movement finds its way over top of ring and up along cylinder wall into combustion chamber. There it burns. Motion sets up a rapid pumping action of rings. That pumps a lot of oil into combustion chamber. Type of rings used governs type of holes to drill. Oil goes into slot of ring and then into crankcase.

P D Hobson July, p 127, seems to associate heavy repair bills with scraper rings. Did he consider these points?

Scoring of cylinders and pistons can be divided into four classes.

Lack of efficient lubrication. Oil in reservoir is too low or empty. Oil strainer clogged, preventing oil reaching bearings. Oil is not right for engine. Too-light oil film on cylinder wall is dissipated by heat of expanding gages. If oil is too heavy, it may not reach top piston ring and piston head in quantity for good lubrication.

Right oil used may be fouled with carbon particles and grit, which collected in crankcase and oil reservoir. This happens if engine isn't cleaned periodically.

Dirty fuel particles pass poorly fitting rings. Or overpriming may dilute oil supply and break down its body. Continuous operation of engine with one or more cylinders not firing. Main connecting rod bearing is loose. Then, more oil escapes at one point, causing pressure to drop throughout system. This prevents pistons and cylinders being properly lubricated.

Above all, keep steady oil pressure at all times. Adjust cylinder lubrication so whole engine gets about one half as many drops per minute as its rated hp divides equally over all feeds. Reduction of this amount is OK at very slight loads. Camacho said his loads are light, which is in his favor to save oil. He can do this not only with holes for scraper rings, but also by carefully adjusting oil feeders at same time.

B A CROSSON *Cranston, R. I.*

I don't agree . . .

FROM MY EXPERIENCE with large 800-hp-and-up gas engines, dual-fuel and diesel engines, Camacho's figure should be nearer 15,000 bhphr than 1500.

F J ARDOLINO *Brooklyn, N. Y.*

Neither do I . . .

WHEN OUR ENGINES get as low as 1500 bhphr per gal, we consider them ripe for overhaul. At that time other conditions usually agree. I would say optimum as well as maximum obtainable lube economy varies with different makes of engines, sometimes with individual units. I run our engines between 4000 and 8000 bhphr per gal.

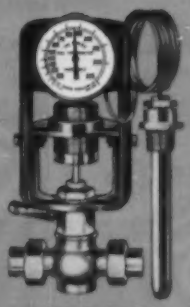
Engine in this plant having most hours since its last overhaul, 6000, is presently giving 4600 bhp per gal. This is a 4-cycle unit. A 2-cycle unit, 2200 hr since overhaul, is giving only about 3000 bhphr per gal. A mating 2-cycle job is giving 8000 bhphr per gal. Scraper rings in first 2-cycle unit were not changed. Rings were put in new in the second engine. Our records of liner measurements—overhaul periods, etc—don't indicate that we are paying any penalty in wear.

I agree with Hobson that lube consumption can be cut too much. But I believe his optimum figure is nearly a minimum. For any economical operation, no general optimum figure can be correct because of differences in engines.

D L COCHRANE *Cambridge, Minn.*

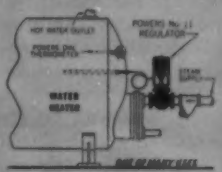
(*More Practical Ideas, p* 140)

WHY POWERS No. 11 REGULATORS Give BETTER CONTROL and Last Longer



TEMPERATURE Indicating Regulator with Single Seat Valve

Simplest, Reliable **TEMPERATURE CONTROL** made for Many Industrial Processes, Heat Exchangers, Air Compressors, Diesel Engines, Fuel and Crude Oil Heaters and Treaters.



SELF OPERATING Needs no Electricity.

Better TEMPERATURE Control results from powerful bellows and minimum of valve stem friction. Valve Stem Lubricator aids easy movement of valve stem without binding. Double ply metal used in Powers bellows outlasts ordinary single ply type.

Balanced (Double Seat) Valve

Controls Flow of Steam, Water or Gas

EASY TO INSTALL bronze union connections for single and double seat valves thru 2" save installation time and labor.

Above: Flanged Iron Body Valve with Double Seat for sizes above 2"

(c44)

● **15 to 20 Years of reliable service** is often reported by users of Powers Temperature Regulators. Since 1891 they have been noted for their sturdy construction and dependability.

● Right type of Regulator and the right size valve is important for best control. From Powers complete line of self operating regulators and air operated temperature controllers you can be sure of getting the type best suited for your requirements. Call our nearest office or write us direct. 3400 Oakton St., Skokie, Illinois. Offices in Chief Cities.

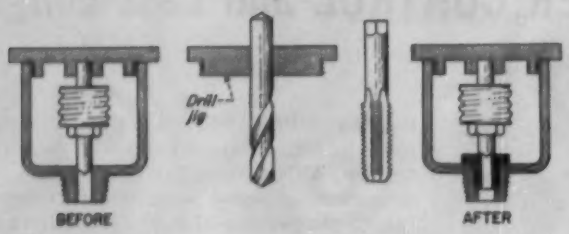
POWERS CONTROL

Since 1891

THE POWERS REGULATOR COMPANY

More PRACTICAL IDEAS

Begins on page 136



$1800 saved by repairing steam traps

OUR HEATING SYSTEM has 840 traps. These are small, thermostatic types, mostly on radiators in our new court houses. Leaky traps have been a problem because valve stem did not seat but was a slide fit into the trap body at bottom, sketch.

Grit in system caused valve stem and seats to wear on sides. Pressure is only 5 psi, but most of the traps were blowing. Replacing would have cost several thousand dollars.

We made a steel jig for screwing into the trap body in place of cover, sketch. Then we drilled and tapped the body for a seat insert. This jig assured the hole and tap being in line with the valve stem. One dozen traps were removed at a time and taken to our maintenance shop. There the work was done at our leisure during summer while heat was off. We figure that our total saving is about $1800. If these traps leak again, they can be ground in, using the drill and tap jig as a guide. Trap body is cast bronze. Our new seats are made of hexagon machine-steel stock.

Since making this repair, I find that many large housing projects have a similar problem. Plumbing is let out on bid, and lowest bidder installs cheapest traps he can find. When they start leaking, building engineer has to either replace them or repair them as we did.

R D JONES *Mineola, N. Y.*

Here's what I would have done

H B MCDERMID July, p 127, describes method to reduce wear of hopper bottoms by sliding sand.

Another method is to cover hopper sheets with an abrasion-resistant coating, such as gunite. This material is widely used to line inside of boiler flues and stacks. It combats effects of high-temperature gas containing particles of unburned coal and ash, at gas velocities of 50 ft per second, and higher.

Although first cost of gunite is greater, my experience is that it gives many years of service to offset this higher expense. That's my suggestion.

H B WAYNE *Brooklyn, N. Y.*

. . . here's my answer

MCDERMID DID OK, but has he considered the cost of labor and material? Brinell hardness test of steel sheets would provide a basic to work from. Next, contact an alloy-steel firm. Here's information I received for a similar job:

Alloy sheet steel, ⅛ in. or less, to resist sliding sand abrasions is heat treated, with Brinell hardness of 341 to 388. It has been used with success. Cost is about twice that of a carbon steel. But there would be savings on labor, also fewer replacements. I suggest readers with similar problems write Climax Molybdenum Company, New York 36, N. Y. Ask for the book, *Alloy Steels Pay Off*. It's full of ideas.

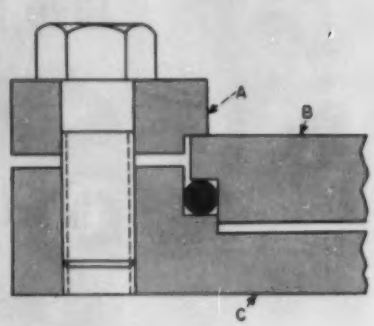
B A CROSSON *Cranston, R. I.*

. . . and here's mine

MCDERMID SOLVED his sand-erosion problem but it was expensive. We had the same problem for years with sand to steam-locomotive sand-domes. Sand was used for tractive effort of brakes. But we stole a page from the monument maker's book. They cut beautiful patterns, plus names and dates, into live rubber, then sandblast the marble through the art work of the rubber.

Our rubber lining in the hopper lasted ten years. That's when diesel engines made locomotives obsolete, but our rubber-lined hoppers were still OK.

P C ZIEMKE *Oak Ridge, Tenn.*



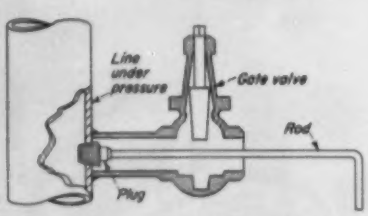
Is this good practice?

THE 20-PAGE SPECIAL SECTION, *Gaskets*, in March 1954, is excellent. On page 124 you illustrate O rings placed between overhanging flanges. I find that bolt pressure springs the flange, thus limiting pressure on gasket. To avoid this, I have made the flange a separate ring, with a shoulder bearing upon the cover or head. With this construction, the bolts may be pulled down tight, giving pressure needed on gasket, sketch.

Normally *A* and *B* are cast in one piece, forming one flange. *C* forms the other flange. *A* is a separate ring with a shoulder pressing *B* against gasket. I used this design with excellent results on a 2-piece valve cage and cylinder head of a multiple-cylinder gas engine.

A Y EDWARDS *Toledo, Ohio*

EDITOR'S NOTE: You may get excellent results with this idea, but an O ring is not designed to be compressed. To make it work properly, designer builds in a little interference, amounting to not more than 10% of ring's diameter. How about this, gasket designers?



You *can* remove plug from live line

PIPE PLUG in line for future connection can be removed from live line without shutting down a system. First, loosen plug. Then weld small-diameter rod, sketch. Weld extra-heavy nipple, threaded at one end only. Screw on gate valve in open position. Bend handle on small-diameter rod so you can screw out plug. Close valve.

D W ANTONACCI *Bolivar, Pa.*

ANOTHER KEWANEE-SPRINGFIELD "PACKAGE" WITH YARWAY BLOW-OFF VALVES

Kewanee-Springfield . . . a good name in package boilers, furnishes *Yarway* . . . a good name in blow-off valves, for dependable blow-down service on their popular boiler line.

It's a good idea . . . used by more and more boiler manufacturers, and appreciated by their customers. Already more than 15,000 boiler plants use Yarway Blow-Off Valves. There must be good reasons . . . *there are.* Yarway Blow-Off Valve Bulletin B-426 explains these reasons. Write for a free copy.

Be sure to specify Yarway Blow-Off Valves when you purchase *your* package boilers.

YARNALL-WARING COMPANY
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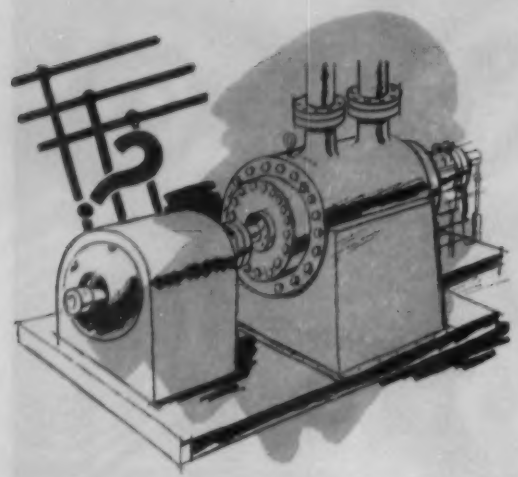
Yarway Type "B" Seatless Tandem Blow-Off Valve. Note balanced sliding plunger design with no seat to score, wear, clog or leak. Pressures to 400 psi.

YARWAY **BLOW-OFF VALVES**

Solving PLANT PROBLEMS . . . readers



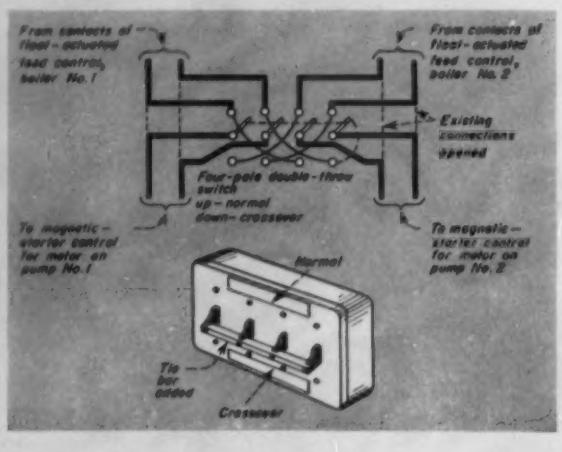
The question

What's good hookup for feed pumps' motor-control flexibility?

THE FACTS: We have two firetube boilers supplying steam for process work. Condensate returns are fed back via a condensate tank and through two motor-driven boiler-feed pumps—one for each boiler. Start-stop operation of pumps is controlled by float-type low-water cutoff and feed regulators. Installation includes piping and valves for feed-pump crossover, so either pump may feed either boiler. But there is no corresponding electrical hookup for crossover feed regulation.

Such a switching arrangement would be highly desirable. I am thinking of using four 3-way switches to do the job, hooking them between the magnetic motor starters, for the feed pump, and the float-actuated feed controls. Is there a simpler way of doing this job? Also, I'm afraid my plan may cause electrical feedback. Can readers improve on my 3-way switch method?—*HRM, July Power*

The answers


From contacts of float-actuated feed control, boiler No. 1
From contacts of float-actuated feed control, boiler No. 2
Existing connections opened
Four-pole double-throw switch up-normal down-crossover
To magnetic-starter control for motor on pump No. 1
To magnetic-starter control for motor on pump No. 2
Normal
Tie bar added
Crossover

For a simple, reliable hookup—try 4-pole, double-throw switch

Switching device shown above is a 4-pole double-throw type. It is a simple arrangement and probably the best way to cross over *HRM's* electrical motor-control connection.

Number of switch poles could be reduced to two if one control-power lead is common to both starter circuits and need not be switched. But for an easy installation with a minimum of wire-tracing headaches, he should use 4-pole arrangement.

Four 3-way switches (as suggested by *HRM*) can make a satisfactory and economical switching device too. Electrical feedback can be prevented by operating all switches as a unit. Sketch above shows a good way to operate all switch handles together.

If they are available, two DPDT (double-pole double-throw) switches will do the same job.

W C HUENING, JR — *Power Systems Engineer*
General Electric Co — *Schenectady, N. Y.*

For your October problems, see page 146

Foolproof solution: Buy third motor-driven feed pump

The simplest foolproof solution to *HRM's* problem is another motor-driven boiler-feed pump.

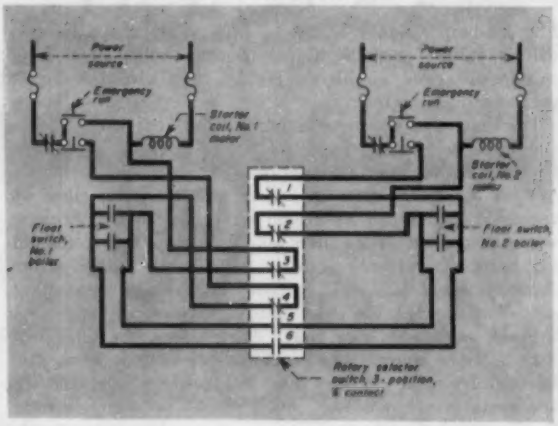
The idea of arranging one feed pump to handle makeup for both boilers can be worked out, but it involves a lot of switching. With such a setup an operator must be on hand to change position of the switches as needed.

The third pump wouldn't require constant switching. It could be connected to either of two magnetic float switches through use of a 3-pole double-throw switch. Center of this switch would supply power to the third pump motor.

G G AVANT — *Wilmington, N. C.*

cure each other's headaches

HOWARD KALLEN, Assistant Editor



Rotary switch will give *HRM* a flexible operating setup

Rotary switching arrangement above is a safe low-cost way to get flexibility in feed-pump motor controls.

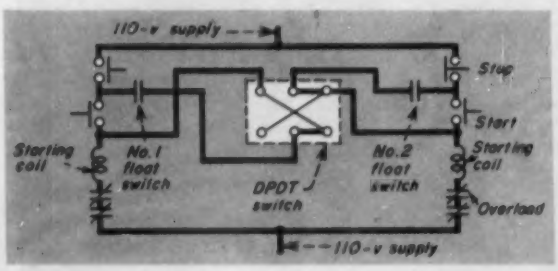
Drawing shows rotary selector switch in its normal position. Contacts 1, 2, 3 and 4 are closed. Contacts 5 and 6 are open. In this position each pump motor is controlled by its own float switch.

First alternate position opens contacts 1 and 2, closes contacts 3, 4, 5 and 6. With this setup, float switch from No. 2 boiler controls feed-pump motor No. 1.

Second alternate position closes contacts 1, 2, 5 and 6, opens contacts 3 and 4. Float switch from No. 1 boiler controls feed-pump motor No. 2.

Contacts 5 and 6 prevent electrical feedback.

E A NUNN — *Seattle, Wash.*



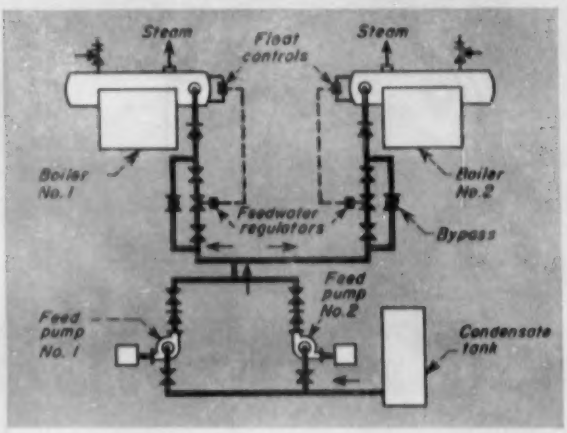
DPDT switch can also do the job

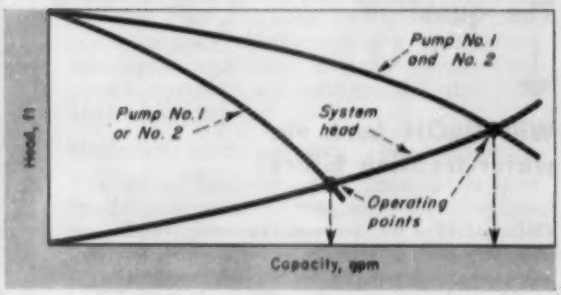
Setup above does the job for *HRM* with a DPDT switch.

In the position shown, each float switch controls its own pump-motor starter. With switch thrown in the alternate position, No. 1 float switch controls No. 2 starter, and No. 2 float switch controls No. 1 starter.

Circuit doesn't present electrical feed-back problems.

J LIGHTFOOT — *Electrical Supervisor*
Polymer Corp — *Sarnia, Ontario*





Right feedwater controls don't need electrical switching

Pump control doesn't necessarily need a corresponding motor-control arrangement. Top sketch shows both pumps operating in parallel and discharging to a common header with branch lines to the boilers. Regulators in each branch line are positioned by water level in each boiler drum.

Under this setup, system hydraulic characteristics allow the pumps to operate in parallel at nearly equal output. Pumps tend to balance output between them. Head-capacity curves, above, show operating points for one- or two-pump operation.

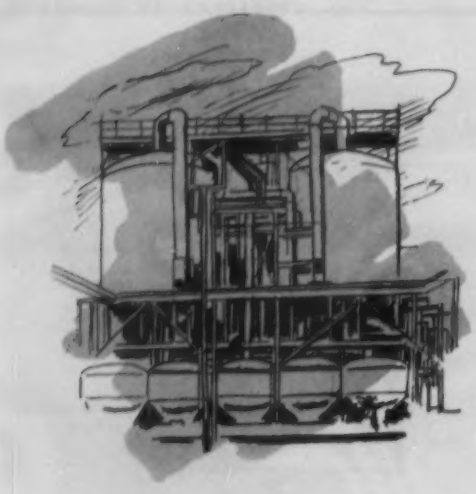
If one pump is out of service, the other pump feeds both boilers at reduced output, as shown by curves. Closing the block valve at the upstream side of the feedwater regulator allows pump No. 1 to feed boiler No. 2, or pump No. 2 to feed boiler No. 1. Block valves on upstream side of feedwater regulator may be manually operated or motor operated by pushbutton control. Such control can be set up for local operation, or at a central point like the boiler-control board. Remote position indicator and colored lights tell operator the control valve position at all times.

H B WAYNE — *Brooklyn, N. Y.*

Turn page for water-filtering tips ►

More PLANT PROBLEMS

Begins on page 142



The question

Will NaOH hurt our water-treating filters?

THE FACTS: We get our raw-water supply from very shallow wells, in sandy ground, but near marshy land. So we've had continual trouble with organic matter. Water is treated with chlorine at the wells. It then goes through filters, preceded by aluminum-sulfate injection. From here it goes to sodium-zeolite softeners and to our factory. Boiler-feed is additionally split-treated through hydrogen-zeolite softeners. Our filters were continually choked with sand clumps due to algae and slime. Backwashing aggravated the situation since the sand bed was cracked. All incoming algae would pass to the softeners and choke them.

Only thing that helped was cleaning the filtering sand, outside the filter, with hydrochloric acid. Recently we cleaned with sodium hydroxide, once in two or three weeks. Immediate results were excellent. But will we ruin effectiveness of filtering sand by using NaOH once in three weeks?—*DR, July Power*

The answers—

How to lick *DR*'s water-treating problem: Move wells to high ground

For good operation it's best to keep slime and vegetable matter out of pressure filters. Deeper wells, back from swamp area and on higher ground, will give *DR* better ground-filtering action.

If capacity of wells on higher ground isn't enough, provide a large settling basin for water storage. Basin can be used during peak-load periods.

With a weir or dam at swamp end of basin, slime or vegetable matter can be floated off while the heavier-than-water suspended solids, like sand, settle to the bottom of the basin. Concrete-lined basin of about a million-gallon capacity would be ideal. It could be drained, cleaned of sand and checked for repairs once or twice a year.

When sand-laden raw water enters filter, the filter bed soon becomes uneven because clumps or mounds form. Result: Differential pressure over bed becomes unstable. In low spots pressure is less. Soon cracks or channels form that impair bed's filtering action.

NaOH or caustic soda is effective for killing bacteria in filters.

Our experience. Once a year the canal we get service water from is lowered to a depth of only a few feet—for about a month. During this period of canal inspection we pump water from a float on the canal. Since suction hoses suck up much sand, mud and dead marine life we have to recondition filters.

Reconditioning. We shut down one filter at a time, remove excess sand, scum and slime, and bring the filter bed back to the right level. We then add clean water to tank, about two inches above sand bed. Next, we inject NaOH or caustic solution from a standard 45-gallon steel drum, mounted on a platform level with top of filter tanks. This setup allows us to use gravity feed.

After injecting solution we seal manhole and allow solution to stand for about two hours. Then, filter is put on *rinse* for eight hours, or until all trace of caustic disappears from rinse water. If even a small amount of caustic is allowed to pass into zeolite softeners, the zeolite is damaged.

Caution: Use rubber gloves and goggles when handling NaOH. It's dangerous stuff.

DR mentions using NaOH every three weeks. It's costly in manpower. Also, using too much caustic soda on nonferrous metals like bronze parts of multiport valves, may ruin them. We believe that too much NaOH rinsing fuses sand to gravel, reducing filter effectiveness.

A BELTON — *Montreal, Canada*

Baffled trap removes sand, slime

I doubt if NaOH will have a bad effect on *DR's* sand. But if it does, sand shouldn't be expensive to replace.

The place to eliminate his trouble is at the wells. Is he pumping too close to the bottom or too close to the top of the wells? Unless he needs all the water wells will produce, there is one best suction level that will ease the sand and slime problem. And chlorine should control the algae.

A baffled trap, close to the wells, will also help eliminate most of the sand and slime. Trap should be of the continuous-discharge type, to get rid of trapped sand and slime.

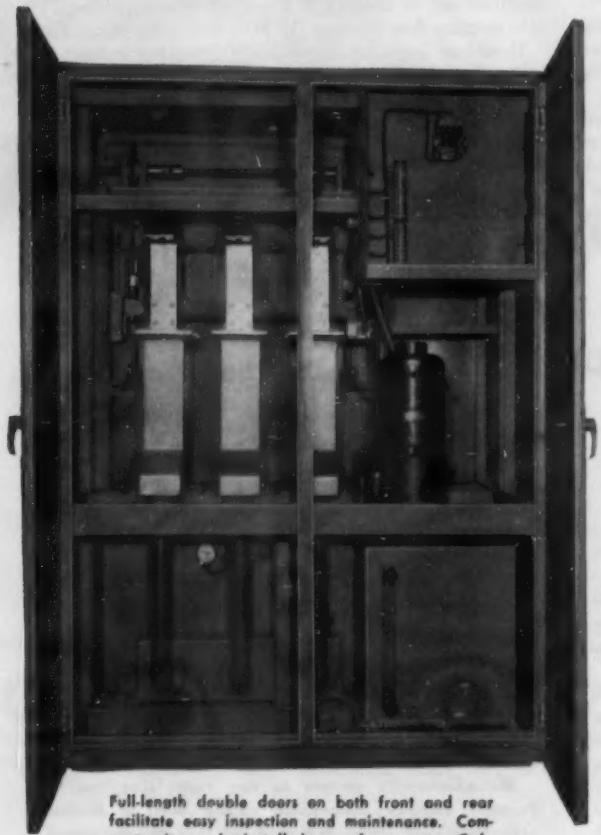
C G HOWARTER — *Canton, Illinois*

For new questions, also more on filtering, turn page

ALLIS-CHALMERS
Liquid Rheostat
BOILER DRAFT
FAN CONTROL

New on the outside...

New on the inside



Full-length double doors on both front and rear facilitate easy inspection and maintenance. Compact unit may be installed away from motor. Only electrical connections are required.

Just about all that remains unchanged in this new unit is its basic time-proved principle . . . a design that provides a wide resistance range with short electrode travel. This gives the smooth, accurate speed control you are looking for.

Modern in performance . . . in appearance

The Allis-Chalmers liquid rheostat is now available in an attractive, safe, clean enclosure. And under its streamlined exterior are many engineering and construction improvements that assure better performance and lower operating and maintenance costs. For example: Individual cells are now constructed of steel for greater mechanical rigidity and protection against accidental damage. Cell linings are of thick, bonded rubber for maximum electrical isolation.

Long-lasting electrodes — removable tips

Electrodes are built up of cupronickel plates. Because this copper alloy is exceptionally resistant to corrosive and electrolysis action, replacement frequency is greatly reduced. If replacement becomes necessary, only removable tips need be renewed.

Low maintenance pump

Electrolyte pump is of the submerged sump type. No packings to be replaced.

For complete information, see your A-C representative or write Allis-Chalmers, Milwaukee 1, Wisconsin for Bulletin 14B8231.

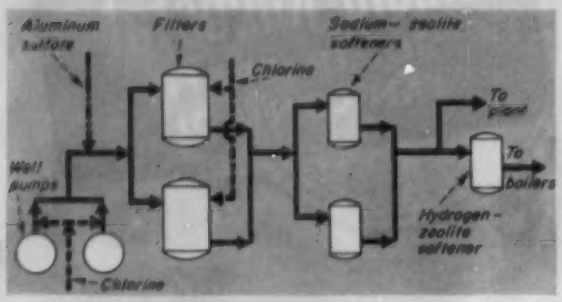
A-4528

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

More PLANT PROBLEMS

Begins on page 142



Heat helps algae, slime grow

Algae and slime exist in an atmosphere of heat and moisture. Even if *DR* injects chlorine into water at wells, algae and slime will grow if the sun's rays are focused on the filter.

When outside temperature is only 80 F, filter-shell temperature can be as high as 130 F. So quite a bit of heat reaches filter sand. With water passing through filter at low rates, available heat is absorbed, to some extent, by water, helping algae and slime grow.

Using NaOH (caustic soda) for cleaning filters is not harmful. Where oil must be removed from filter beds, scouring with a dilute NaOH solution during backwashing periods does a good job. Scouring should be done near solution's boiling point. Solution is kept in contact with the bed for nearly an hour. NaOH saponifies, dissolves animal or vegetable oils and greases.

By injecting chlorine at the filters and at the wells, algae and slime will not form. So need for washing filters with NaOH is avoided.

Hookup drawing, left, shows chemical injection points.

H B Wayne — *Brooklyn, N. Y.*

Are filters correctly operated?

I suspect that *DR* isn't operating his filters right. Chlorine dosage at the wells should kill any algae or slime in his water supply.

When a filter is placed in service, the bed is clean and water passes through it at relatively high speeds. Speed may be great enough to carry suspended matter deep into the filter bed, or through it. Flow-rate instruments will maintain uniform flow through the filter bed automatically.

Head-loss gages on filters are a good indication of filter bed's condition, tell when backwashing is needed. Wash water should be admitted to filters slowly. Sudden rush of water will dislodge the filter bed.

Also important: Keep filter operating record. Test raw and treated water at regular intervals. If condition continues, *DR* should consult a water-treating specialist.

G G Avant — *Wilmington, N. C.*

YOUR OCTOBER PROBLEMS

1 Is this byproduct power setup best for us?

We have a 100,000-lb-per-hr boiler, now operating at 190 psig, 520 F. Unit is designed to run at 475 psig, 720 F.

We plan to buy a backpressure turbine that will take 450-psig, 750-F throttle steam and exhaust into the plant high-pressure steam system at 190 psig, 500 F.

All steam generated by the boiler will pass through the turbine. Bypass arrangement consisting of a desuperheater and reducing valve will cut in automatically if steam demand exceeds that going through the turbine or if the turbine is out of service.

My figures show that about 2000 kw could be generated at full load and that full-load steam rate would be about 30 lb per kwhr. Steam rate at half load would be about 60 lb per kwhr.

Does our plan conform to sound engineering practice? Do *Power* readers know of successful installations operating under these approximate conditions? What would be the approximate cost of such a unit?

Our steam load varies from 100,000 lb per hr during winter weeks to 18,000 lb per hr during summer weekends.—*LML*

2 Why does pump motor pull more current than nameplate rating?

When we ordered a motor-driven centrifugal pump recently, we specified a stainless-steel shaft.

After installing pump we found that the motor draws one-third more current than the nameplate rating. The plate-rating amperage is normal—7½ hp, 21 amp at 220 volt, 3 phase.

Manufacturer's answer to our complaint was to furnish another nameplate rating with a higher amperage—28 amp. We contend that the increased current is due to installing a nonmagnetic stainless steel that adversely affects the rotor's magnetic field. Magnetic type of stainless steel should have been used. What opinions do *Power* readers have on this matter? How can we avoid this condition?—*FCV*

Sit down right now and answer one or both of these problems. We'll pay extra for answers with photos or sketches.

BETZ • *A Great Name In Water Conditioning*

Welcome visitor...

The Betz District Engineer is a welcome visitor wherever he goes. As our personal representative to industrial plants, petroleum installations, institutions . . . plants like yours, he plays an all-important role in our continuing efforts to engineer *controlled* water conditioning.

His job carries many responsibilities. For example, he

. . . instructs your plant operators in Betz-engineered water conditioning control techniques (chemical feed, water testing, chemical adjustment, blowdown control, etc.).

. . . makes regularly scheduled visits to your plant to review operating conditions.

. . . reviews plant control and offers "on-the-spot" constructive criticism and advice.

. . . checks testing procedures, test solutions and chemical feed equipment.

. . . inspects plant equipment and visually observes the results obtained.

. . . discusses any and all water problems with you and your operating personnel.

. . . prepares and submits a complete written report before leaving your plant.

And equally important, he works closely with the Betz headquarters engineering staff to assure the individual attention required for sound, economical water conditioning.

Next time a Betz District Engineer calls, ask him to explain how Betz *completely-integrated* water conditioning service can obtain results in *your* plant. He'll be happy to give you the details.

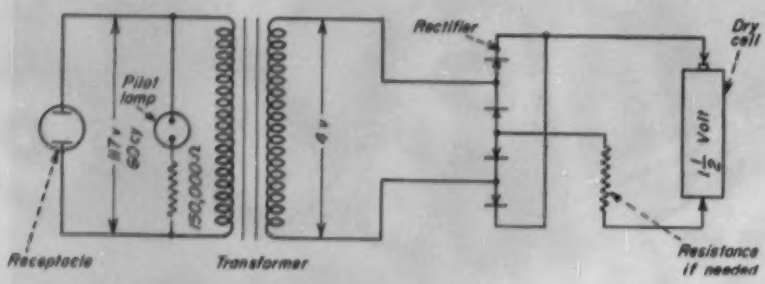
W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories Limited, Montreal 1.

BETZ

CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

ARGUMENTS . . . pros and cons from readers' letters

ALTHEA THORNTON, *Assistant Editor*



Setup recharges dry cells—is it worthwhile?

MOST DRY CELLS are thrown away long before much of the zinc is used up. They seem inexpensive, but cost per year adds up if discarded too soon.

Dry cells can be recharged to get several times the usual life. Best time is when cell just begins to lose voltage. In a flashlight, this is when the light starts to lose brilliance.

Recharge by sending a direct current of about half the discharge rate through the cell in the reverse direction. Connect the positive line of the charging current to the positive or plus terminal of the cell for about twice the time the cell has been in use. See sketch.

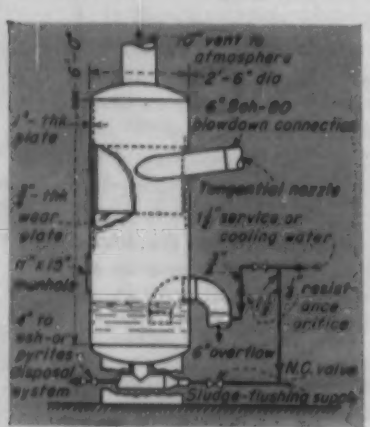
You need a small stepdown transformer and a rectifier, possibly of the selenium type. Resistance in the main circuit should hold the current down to the amount required for charging. I use about 150 milliamperes for a partly rundown cell. The neon pilot lamp consumes 1/25th watt and indicates that unit is on charge. Part of a fruit-juice can will shield the pilot-lamp assembly, preventing contact with 117 volts.

Adjust the clamping screws for different-size cells, or use a higher dc voltage to recharge several cells in series.

After recharging, let cell rest several hours so it can settle down to its correct voltage. If rectifier becomes too hot to touch, increase resistance to reduce the current to what the rectifier can handle.

GEO PEARCE *Albuquerque, N. M.*

EDITOR'S NOTE: *Do you readers think it's worthwhile to do this?*



Swygert wants more info about blowdown tank

BLOWDOWN TANK above was suggested by A J Breugelmans in March POWER, p 144. But I have some questions:

(1) Why should a vented blowdown tank be designed in accordance with *ASME Unfired Pressure Vessel Code?* (2) Why place wear plate on the inside of a blowdown tank in preference to the outside? (3) Shouldn't he give exact location where the blowdown line connects to the tank? (Rules of the National Board of Boiler and Pressure Vessel Inspectors recommend that drain be located so as to drain only 50% of tank's volume.) (4) What should the limiting factors be for the thickness of the blowdown-tank plate?

Here's another point to consider when designing a blowdown system: Long blowdown lines drain more quickly and operate with less shock if you make provision to break the existing vacuum. You can do this by installing a ¾- or 1-in. check valve turned inward at end of blowdown header.

H B SWYGERT *Greenville, S. C.*

Breugelmans elaborates on the blowdown tank

THE DRAWING Reader Swygert refers to (below, left) is a typical blowdown tank used in many of my company's power plants for 1500- and 2100-psi boiler and turbine installations. Here are my comments on his questions:

1. Paragraph Uld3 of *ASME Unfired Pressure Vessel Code* states that vessels having internal or external pressure not exceeding 15 psi, with no size limitations, do not come under the code. I recommend ASME design for the tank. This rules out construction by any manufacturer who cannot make a good-quality welded tank.

2. Put wear plate on the inside surface so erosion caused by the entering water-and-steam mixture can be easily repaired with weld overlays. Such erosion on the main structural member of the tank would weaken the wall.

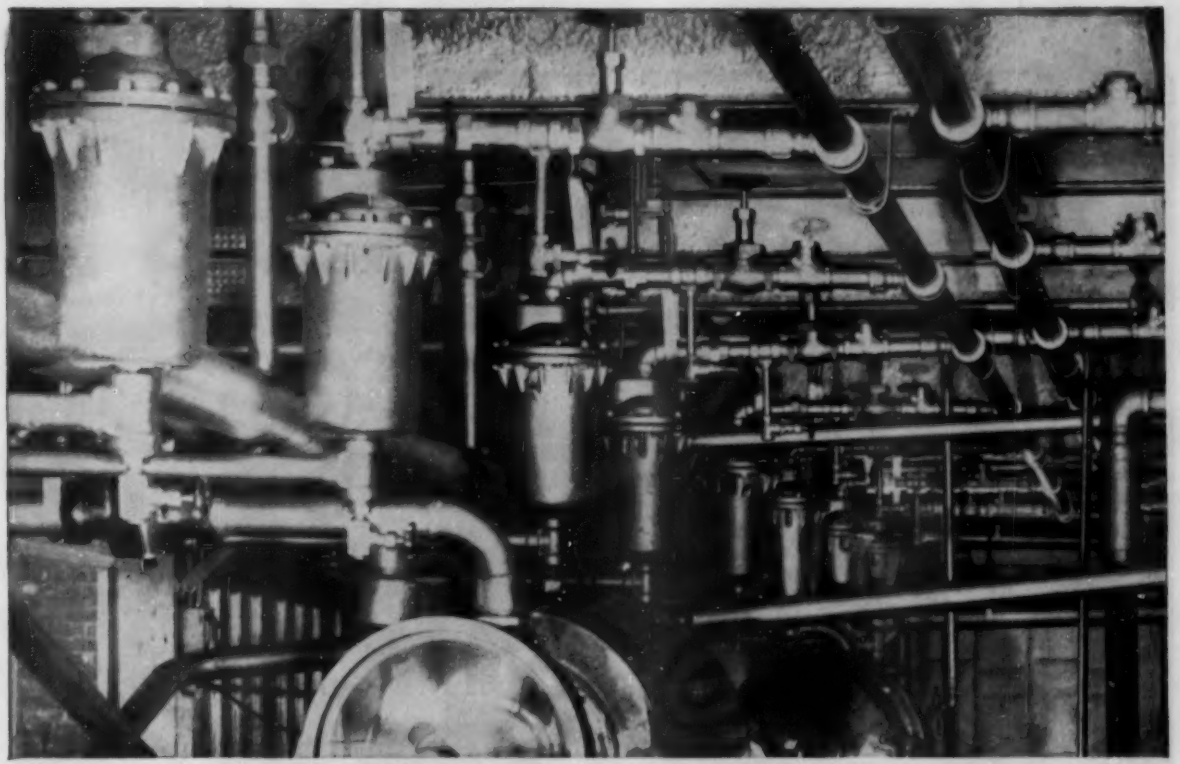
3. I don't think the blowdown line should be lower than a third of the tank height from top of the dished head. My sketch was not dimensioned to emphasize this point, but it was implied. With the "overflow" about a third up from the bottom, tank has a middle region for separation, with centrifugal action, of the flashing mixture.

The National Board of Boiler and Pressure Vessel Inspectors' rule that Swygert refers to is true, but the tank under consideration is adequately vented to atmosphere; hence the rule does not apply. There may be state codes covering such blowdown tanks. But I have installed similar units in Indiana, Ohio, Virginia and West Virginia, and have not yet had difficulty.

4. Factors limiting plate thickness for a tank vented to atmosphere would be amount of blowdown and, hence, flashing conditions causing erosion. Corrosion must be considered, too, because fluid collected has a high concentration of salts. Sometimes raw waters used for makeup have high chloride concentrations. These are difficult to remove.

The wall should be heavier than ⅜ or ½ in. for atmospherically vented tanks, depending on size. Add an internal wear plate. Within economical plate costs, this yields a longer tank life. In addition, maintenance costs will be lower, and you will get longer service between internal inspections.

A J BREUGELMANS *New York, N.Y.*



How To Increase Production and Still Use Less Fuel!

Problem—Cooking kettles at National Cranberry Company, South Hanson, Mass., couldn't produce enough to supply three recently speeded up canning lines. There was neither enough space nor steam supply capacity to add more kettles. Might there be another answer?

Solution—Mr. Russell Appling, Production Manager, made a very logical move, with everything to gain and nothing to lose. He called his local Armstrong Representative to talk about re-trapping his set-up. The existing traps were replaced with Armstrong 2″ No. 216 large vent traps, one on each of the 8 kettles. Additionally, the steam lines were trapped to assure a dry steam supply.

Results—30% more kettle production. A fourth canning line was added to keep up with output. And, fuel consumption dropped 30% despite the production increase!

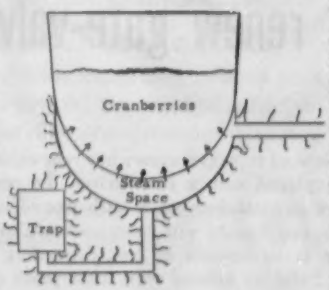
If you want more efficient production, greater return on equipment investment, why not call *your* Armstrong Representative. See your classified phone directory or Thomas Register, or write:

ARMSTRONG MACHINE WORKS
812 Maple Street, Three Rivers, Michigan

Application Engineered

ARMSTRONG STEAM TRAPS

HOW A KETTLE CAN GIVE *30% MORE OUTPUT WITH 30% LESS FUEL*



Assume that with trap "X", inadequate for the job, cooking time is 10 minutes. During that period heat is radiating (wavy lines) from supply lines, kettle and trap. This non-productive heat loss wastes steam. Now, with an Armstrong trap keeping the steam space free of air and condensate, heat transfer rate is fast and cooking is done in 6 minutes. Thus, four minutes of non-productive radiation loss is eliminated—the faster cooking actually saves steam.

1 Remove bonnet from valve body

HOW TO

renew gate-valve seat

► NEW GATE VALVE shown has renewable seat rings that can be replaced with a screwdriver. To renew, remove bonnet, screw out retaining screw with screwdriver. Lift out old seat rings and replace with new, photos. Claim is that this can be done in 10 minutes or less, depending on scale and solids that build up around seats after years of service.

Screws are silicon bronze to lessen chances of galling or freezing. These screws have fine pitch threads so they won't back off in service as easily as standard threads might.

Valve comes in both rising stem and nonrising stem. Built for service up to 200-psi steam. Also for 400-psi water, oil or gas requiring full flow and frequent operation. Seat ring is monel and wedge is nickel alloy.

Valve is of union bonnet construction, with radial body bonnet joint reinforced by a heavy octagonal union nut.

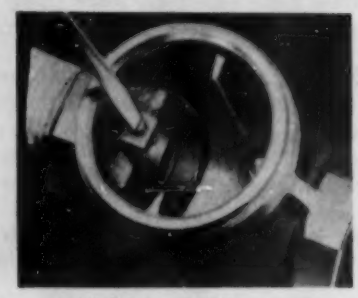
This is the first gate valve designed with seat rings that can be replaced with a screwdriver to cut down on maintenance.

—Courtesy, The Fairbanks Co, New York, N. Y.

2 Screw out retaining screw

3 Lift out seat ring

4 Insert new seat ring

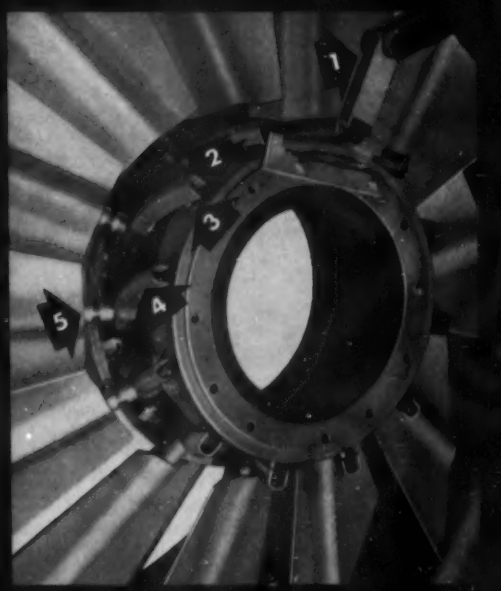


5 Tighten retaining screw

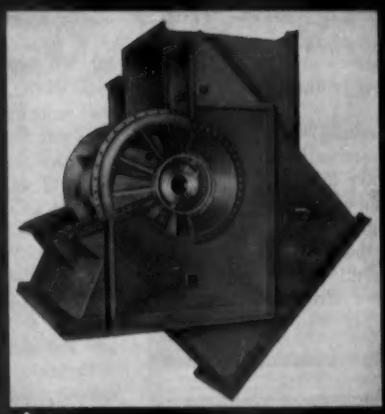
6 Replace bonnet and tighten

Fact:

STURDY WESTINGHOUSE-STURTEVANT INLET SPIN CONTROL SAVES FAN POWER WITH CONSTANT-SPEED MOTORS



5-POINT POSITIVE OPERATION. As link and lever (1) moves the operating ring (2) hardened steel spherical pins (3) turn crank arms (4) welded to the tubular vane cores (5). Each vane turns on a heavy steel rod anchored between the center mechanism and outer steel support. No lubrication is required.



Operating mechanism is shielded from the gas stream but is readily accessible from the outside for inspection and maintenance.

SPIN CONTROL CUTS OPERATING COST

The combination of Westinghouse Inlet Spin Control and the simple squirrel cage constant speed motor is less costly to install and provides greater overall power savings than other types of mechanical draft control.

SMOOTH, SIMPLE ACTION

Inlet Spin Control has no gears—no backlash. Provides instantaneous control of draft. Vanes move rapidly in the open range, yet fine adjustment is possible in the near-closed position. Extremes of heat and cold do not affect its operation in any way.

MOST EFFICIENT, MOST ECONOMICAL

In any comparison of both forced and induced draft fans and their control devices, you will find Inlet Spin Control is both the most efficient and economical choice.

MORE FACTS?

Call your nearest Westinghouse-Sturtevant Sales Engineer . . . he's the "Man with the Facts". . . or fill in the coupon below.

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Please send more facts on Inlet Spin Control.

NAME AND TITLE.....

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BASICS . . . bringing engineering theory down to earth

HOWARD KALLEN, Assistant Editor

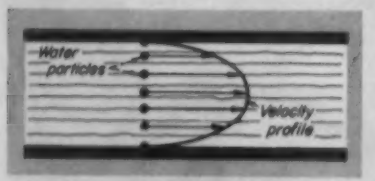
FLUID FACTS — 2:

What does viscosity really mean?

► LAST MONTH we talked about density and fluid characteristics related to it—specific volume, specific gravity. Important, also, as a basic tool in solving fluid-mechanics problems, is viscosity. It's a property often misunderstood by engineers.

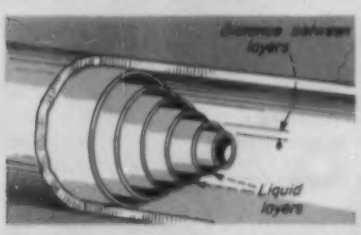
What is viscosity? Viscosity, in effect, tells us how well a fluid can flow. If we pour heavy lube oil across a surface, do the same with water and compare spreading speed, we get a pretty good idea of their relative viscosities. Slower-moving oil is more viscous.

Let's see how viscosity affects pipe



flow. When we speak of liquid speed through a pipe we're actually referring to an average speed. Liquid layer contacting pipe wall is stationary. Speed increases with increasing distance from wall, reaching maximum at center of pipe. Knowing velocities at several points in a plane (at right angles to pipe's axis) we could draw a *velocity profile* representing different fluid speeds, sketch above.

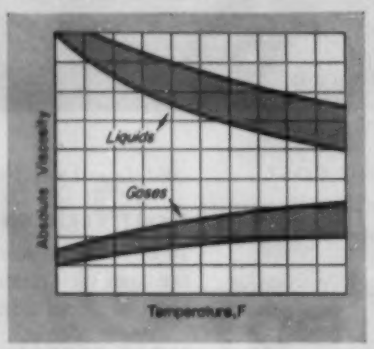
Now let's assume that liquid flowing through pipe is made up of many concentric layers or *tubes*. Inner tubes are moving faster than those nearer pipe wall. Shearing action or force exists between any two adjacent tubes because of cohesion between liquid molecules that make up the tubes. If we divide velocity difference between two tubes by distance between them, result



is proportional to the extent of shearing action. In a highly viscous fluid, shearing forces are big, velocity differences between concentric layers are small—mainly because of relatively strong cohesive forces between layers or *tubes* of molecules. *Viscosity index* or *absolute viscosity* is nothing more than a ratio of the shearing force (stress) and the velocity-difference effect between adjacent fluid layers.

Notice that our definition of absolute viscosity agrees with the first pass we took at defining viscosity—how well a fluid can flow. As shearing forces go up and velocity-difference effect goes down, fluid's resistance to flow increases. Net result is a more viscous substance, showing up as a larger figure for absolute viscosity.

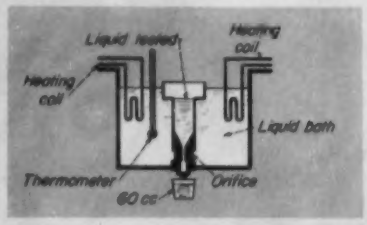
Temperature has strong influence on viscosity. Rising temperatures trim down cohesive forces between liquid molecules, shave liquid's viscosity. Surprisingly enough, temperature has the opposite effect on gases. But there's a good reason. Cohesion between gas molecules far apart is negligible. Shearing action between moving layers of gas



is due to agitation of gas particles rather than cohesive forces. Since high temperatures boost activity of molecules, shear force—and viscosity of gas—rises with increasing temperatures. But viscosities of gases are always less than of liquids, graph above.

Viscosity units can be tricky, mainly because they show up in both their English and metric forms. Common practice today is getting away from English units, uses the *poise* or *centipoise* as the unit of absolute viscosity. Handbook tables and charts show how absolute viscosity of various liquids and gases varies with temperature.

Measuring absolute viscosity is a tough job, calls for complex equipment. *Kinematic viscosity*—the absolute viscosity of a fluid divided by its density—is much easier to measure. So engineers frequently use it directly in flow problems. Saybolt Universal viscometer



is the standard way of measuring kinematic viscosity in the U.S. Liquid passes through an orifice in the instrument. Time needed to pass 60 cc at a specified temperature is the Saybolt Universal viscosity. If an oil takes 85 seconds at 100 F, its Saybolt Universal viscosity is 85 ssu.

Metric unit for kinematic viscosity—the *stoke* or *centistoke*—often shows up in flow formulas. So handbooks list conversion factors that convert ssu to centistokes. Also, knowing fluid's density or specific gravity we can get absolute viscosity in centipoise.

Let's work out a problem using these units. Suppose Saybolt test takes 85 seconds to pass 60 cc oil at 100 F and specific gravity at same temperature is 0.90. We want to know its kinematic viscosity, in centistokes, and its absolute viscosity, in centipoise. From formula:

$$s = (0.22 \times \text{ssu}) - (180 \div \text{ssu})$$

where

s = kinematic viscosity, centistokes
ssu = Saybolt Universal viscosity, sec
$s = (0.22 \times 85) - (180 \div 85)$
$s = 16.6$ centistokes

To get absolute viscosity at 100 F we multiply kinematic viscosity by specific gravity:

$$p = 16.6 \times \text{sp gr} = 16.6 \times 0.90$$
$$p = 14.95 \text{ centipoise}$$

Conversion factors allow using these metric units for viscosity directly in English-system flow formulas.

for lower cost control of moderately **Corrosive** fluids

Fig. 2651-A Gate

JENKINS

NICKEL IRON

Valves with Type 316

STAINLESS STEEL

Trim

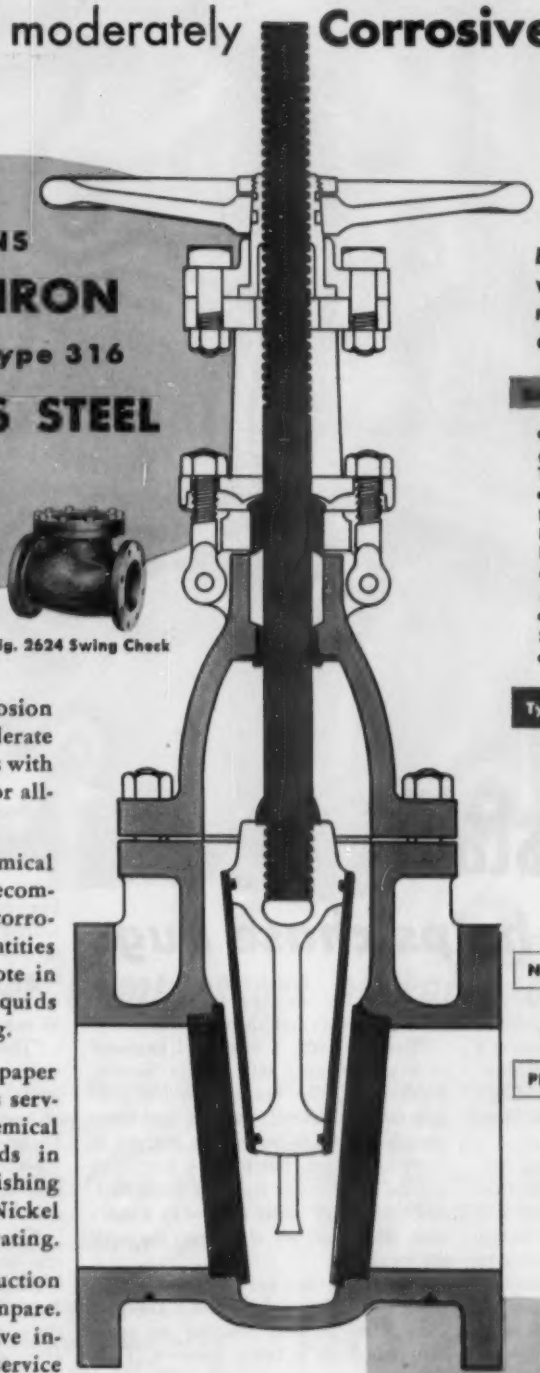


Fig. 2624 Swing Check

Every part in contact with fluid is the right metal to block corrosion and beat wear.

[illegible] NICKEL IRON

- **BODIES** Heavy duty, dimensioned for greater resistance to wear and abuse. Through port design in Gate Valves.
- **BONNET** Rugged construction, like body. Swing-type gland bolts. Screwed-in back-seating bushing. Deep stuffing box.
- **YOKE** Integral with bonnet in 2" to 4" sizes.
- **WEDGE** In 10" to 24" sizes, with Stainless Steel Wedge Rings.
- **COVER** In Check Valve.

Type 316 STAINLESS STEEL

- SPINDLE
- GLAND
- BONNET BUSHING
- SPINDLE RING
- WEDGE PIN
- WEDGE RINGS Rolled into Nickel Iron Wedge in 10" to 24" sizes.
- SEAT RINGS
- DISC and HANGER in Check Valve

NI-RESIST Type No. 2

- WEDGE of I-beam structure is solid NI-RESIST in 2" to 8" sizes.

PRESSURE RATINGS

2" to 12"—200 lbs. O.W.G.
14" to 24"—150 lbs. O.W.G.

This combination provides corrosion resistance well above the moderate need in many processing services with an investment well below that for all-stainless steel valves.

Designed primarily for the chemical process industries, they are recommended for control of mildly corrosive liquids with minimum quantities of mineral acids, such as creosote in wood treatment, and many liquids carried in petroleum processing.

A major use is in pulp and paper processing, particularly in lines serving the digester, and in the chemical recovery cycle. Service records in lines carrying the valve-punishing "black liquor" give Jenkins Nickel Iron Valves top performance rating.

Jenkins *extra value* construction throughout. Get details — compare. See why they stretch your valve investment dollar — with longer service life, lower maintenance cost.

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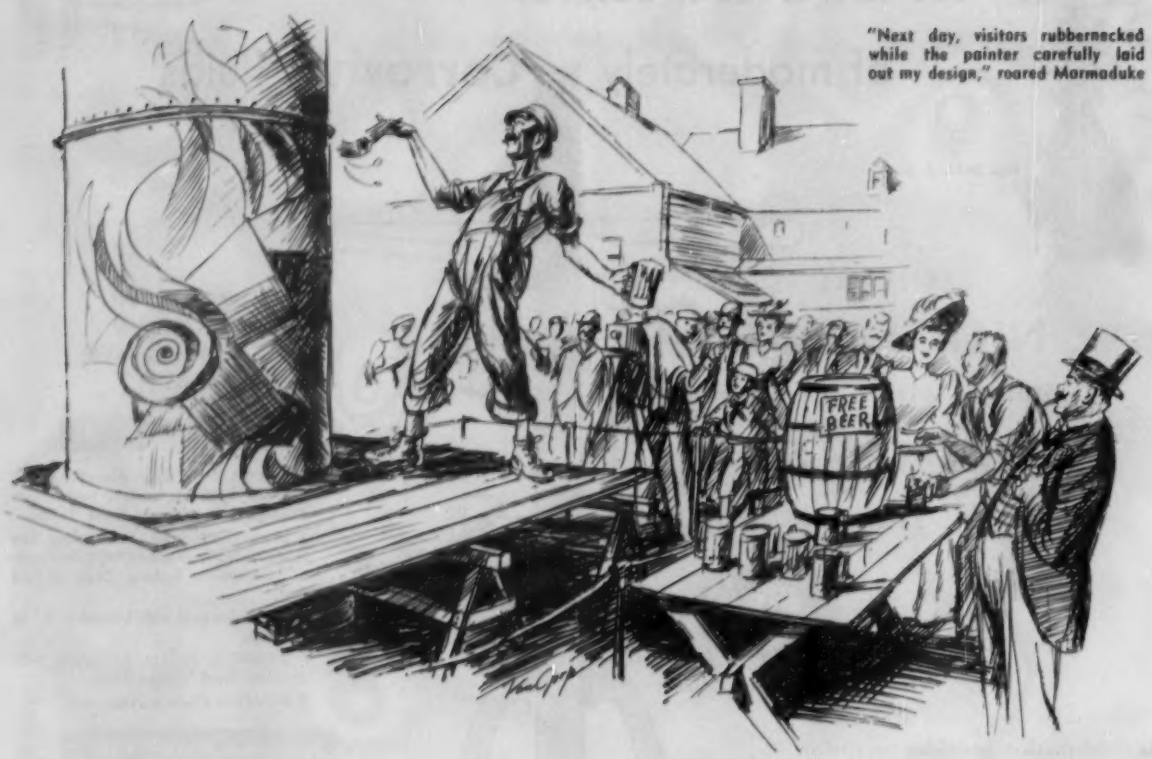


"Next day, visitors rubbernecked while the painter carefully laid out my design," roared Marmaduke

Brewery stack

helps chase bugs

► "BILGEWATER on top management that tries to do bottom management's work," roared Marmaduke Surfaceblow, Esq, one day last week in his dingy office above O'Houlihan's Machine Shop & Engine Works.

Why did the cantankerous old consulting engineer burst out with that statement? Don't ask me. All I know is that I had dropped in to get a lineup of recommended books for operators to read before taking their license examinations. There I was, sitting on his ancient settee, embalming myself with a cup of his black coffee and coughing quietly. The old boy was laying down a Ringelmann number 8 smoke-screen as usual, while juggling some mysterious figures at his roll-top desk. Suddenly he threw down his pencil and made that outburst. Before I knew what he was up to, he poured himself a cup of drain cleaner from the pot on the old pot-bellied stove, plopped his size-16 canal boats up on his desk, puffed furiously at his cigar butt, and then blasted away.

"Back in 1902, I was chief engineer of a small paper mill out in Seattle, Washington," he croaked in his bull-frog voice. "The mill was new and there were mistakes to straighten out, as in every new plant. But I had a free hand and no interference from the brass hats, so I had things under control in a short time. That sent my stock way up with the owner.

"About the time our plant was sailing along smoothly, my boss and a group of local business men coughed up some cash and built a fancy brewery. They got a temperamental brewmaster from Germany and put him in charge.

"The power plant had the usual corliss engines, directly connected to large vertical angle-type ammonia compressors. Large watertube boilers burned hog fuel and were hand-fired. When the brewery was finished, its power plant was the talk of Seattle. There was more red paint, shined brass and copper than anybody had seen around those parts.

"Finally the big day came and the new chief started his plant. But he had tough sailing from the very first minute. For one thing, the owners made a tourist attraction out of the place. Then to top it all, the brewmaster started throwing fits if the engineers didn't drop everything and come running every time he snapped his fingers, which was often.

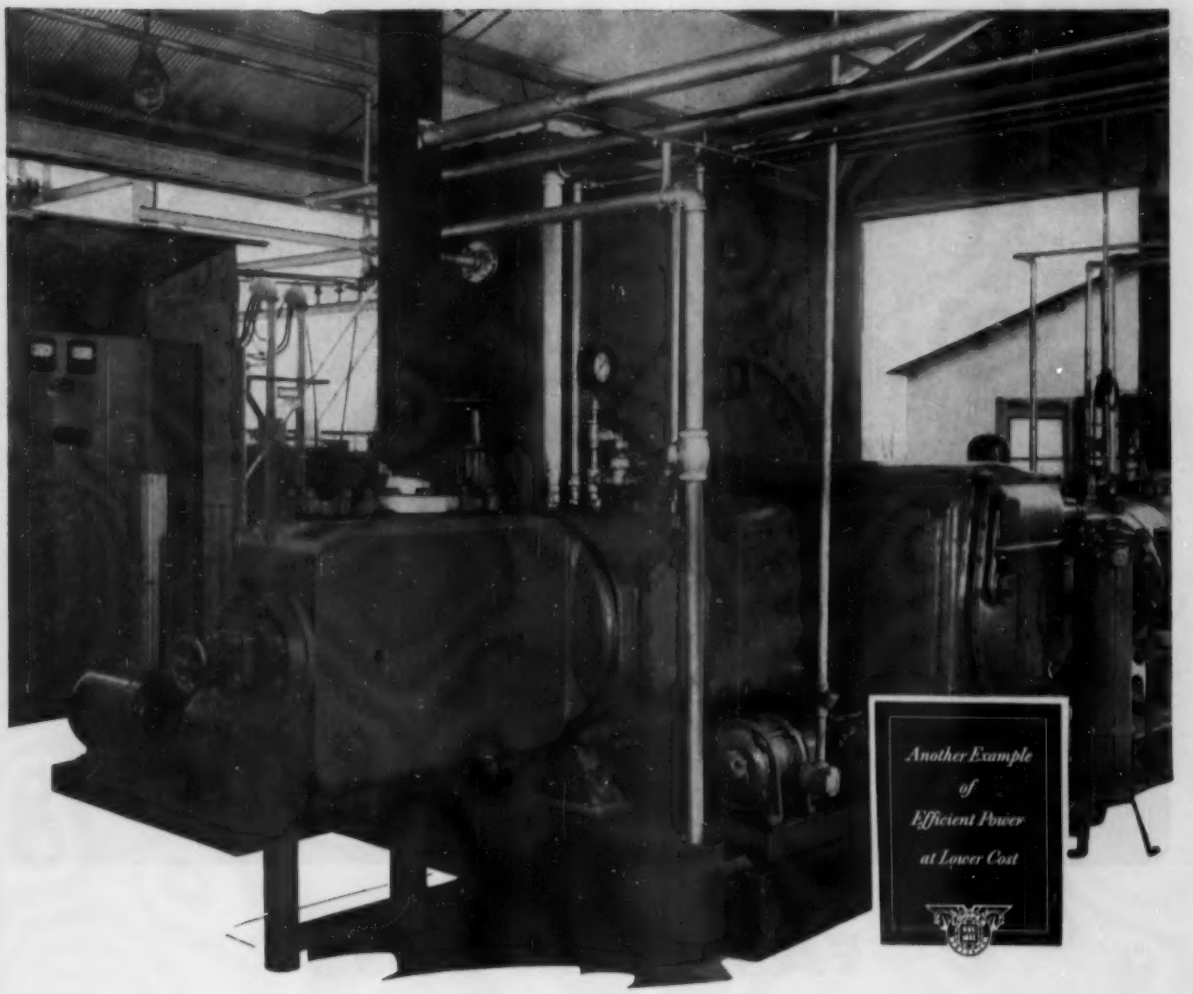
"There were visitors everywhere. They were taken through the boiler and engine rooms and given free beer. Kegs of beer had been shipped up from San Francisco months before for this opening-week celebration. That solved the beer-aging problem all right, but it didn't help the engineers.

"That power plant had the latest boilers and equipment. Everything was engineered for top efficiency in those days. But that plant still didn't work right and didn't have the needed output after a week's operation. That's when my boss, who headed the group of owners, sent me an SOS.

" 'Mr Surfaceblow,' he began, 'you did such a swell job getting my paper plant started that I wish you'd get the bugs out of our brewery plant. I'll have a nice check for you if you can tell us what's wrong.'

"I spent the next day navigating

(*Continued on page* 198)



Cooper-Bessemer Compressors operate "on their own"

ACTUALLY, the statement that Cooper-Bessemers are "on their own" is far from an exaggeration. For example, this single stage Cooper-Bessemer FM-2 compressor, installed in a Michigan refinery, runs 24 hours a day without operating personnel.

This money-saving advantage is made possible by highly efficient Cooper-Bessemer controls which automatically handle all phases of the compressing operation.

Moreover, in this plant's processing, contamination by oil is completely avoided. Therefore, the FM unit is equipped with Cooper-Bessemer *carbon pistons*, operating against micro-honed mirror finish liners, requiring no lubricating oil whatever! — a highly important factor in various processes involving compressed air and other gases.

Whatever your compressor requirements may be, from 100 to 5000 hp, Cooper-Bessemer offers you unique advances assuring the highest efficiencies combined with lowest cost operation. Your nearest Cooper-Bessemer office will gladly give you the specific information you may require.

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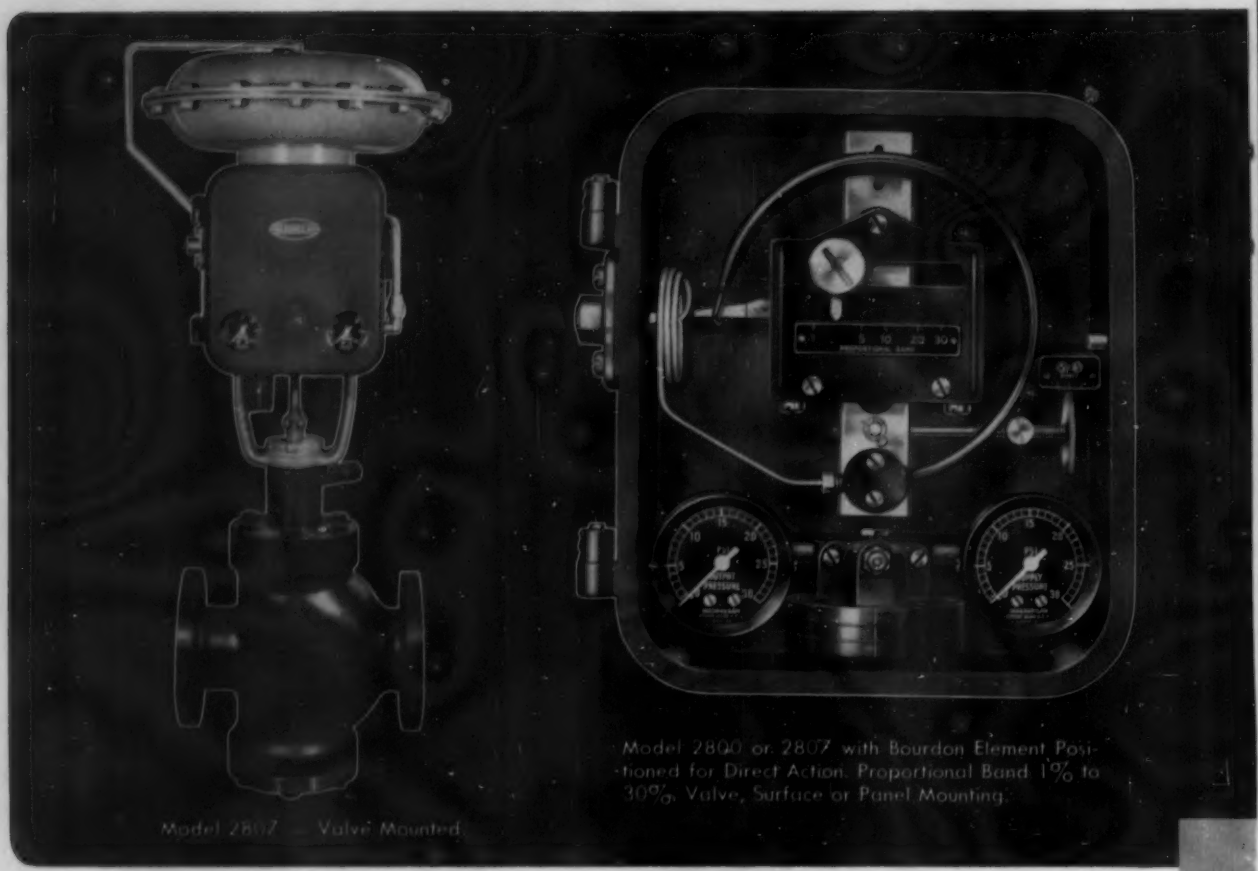

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Reader service section

Start with these quick samples . . .

Two for the show...

Canada's 1955 Power Show in Montreal and the Chicago Exposition of Power and Mechanical Engineering make November "show" month for power engineers. And atomic energy will play the leading role in both events, but naturally.

Reports From the Field, p 160

Top 28 technical papers...

are abstracted and listed for your rapid review. What better way is there to keep pace with the fast-moving power field? And, if you want the complete report, there's info on where to get it.

Technical Briefs, p 162

Happiest wedding in years...

electrically speaking, joins together a current-limiting device and a standard molded-case circuit breaker. Result: a protector with short-circuit interrupting capacity of 100,000 rms amperes.

Plant Equipment News, p 166

If it's NEW...

related to the power field, and in bulletin form, chances are you will find it briefed in POWER. If the sampling is to your liking, use our convenient post cards to get those bulletins you want.

Free Literature, p 175

But if it's OLD...

it's not necessarily forgotten. George Edwards dug back to an 1894 issue of POWER, plucked the story of the Henry Clay chain-reaction boiler blast. Sensational when it happened, it still makes lively reading today.

George Edwards' Scrapbook, p 178

"Everything and the Kitchen Sink"

is intriguing title of a book dealing with the inventions and technical developments of the past 100 years and Crane Co's contributions. Progress it records is primarily technical.

Bookshelf, p 192

For other timely ideas, see following service pages ▶

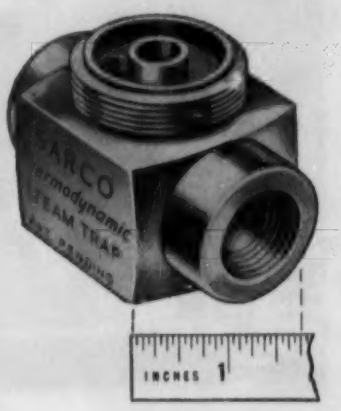
Now — A Revolutionary NEW Steam Trap!

What could be simpler?

1. A CAP

2. A DISC

3. A BODY



That's all!

Practically Eliminates Maintenance!

Look at this revolutionary new thermodynamic steam trap. Could it possibly be simpler? Look for the valve closing mechanism—there isn't any! The kinetic energy of steam closes the valve and *only* the TD uses this new operating principle.

Only 3 parts... cap, disc and body... machined from stainless steel bar stock... all extremely simple, rugged, durable. Only one moving part... a hardened SOLID stainless steel disc... practically wear-proof.

Just imagine how much time and expense this new TD steam trap can save you by greatly reducing and simplifying trap maintenance and inventory!

SOME OF MANY OTHER ADVANTAGES:

1. Use the same trap for 10-600 psi... for light or heavy loads ... without seat or valve change or other adjustments.
2. Closes tight on no load — no steam waste.
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4. Not affected by superheat, water-hammer, corrosive condensate.
5. Only one spare part—solid stainless steel disc.

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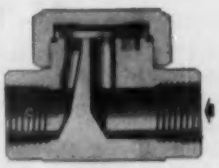

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Thermodynamic Steam Traps

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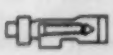
Float Thermostatic Steam Traps

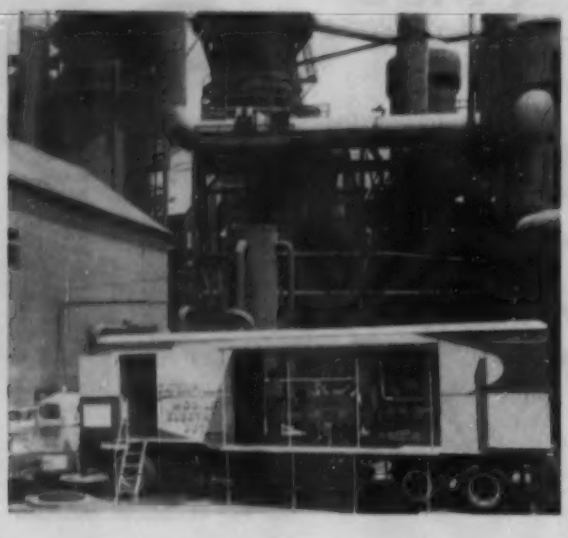

Liquid Expansion Steam Traps

Camlift Bucket Steam Traps

REPORTS FROM THE FIELD

What's happening in power and what it means to you

For Calendar of Events see page 234



Emergency needs met by mobile power set

► WHILE UTILITY SERVICEMEN altered electric circuits, emergency power for protection of vital equipment at the Midland, Pa. mill of Crucible Steel Co of America was supplied recently by a 500-hp Caterpillar diesel-electric set. This mobile unit operated water-cooling pumps to prevent blast furnaces from burning out—averting possible damage that could well have sky-rocketed to a million dollars.

The Caterpillar D397 engine and generator are mounted on a van-type trailer and comprise the largest road-borne emergency unit yet developed. Since its assembly about a year ago, the set has served in nine areas stricken by storms, floods, fire or other causes of power failure.

Operated by one man, this emergency plant can be hooked up and furnishing power within 15 minutes after arrival at any location. At Midland it supplied electric power for 48 hr of continuous operation of the water pumps. It can be operated for an indefinite period without variation in its electric current output. The set burns ordinary furnace oil.

Chicago Power Show to have atomic power section

► AN ATOMIC POWER SECTION promises to be one of the highlights at the Chicago Exposition of Power and Mechanical Engineering. The exposition, to be held Nov 14 to 18 at the Chicago Coliseum, will be under the auspices of the American Society of Mechanical Engineers, whose Diamond Jubilee Annual Meeting, during the same week, climaxes this year's celebration of the Society's 75th year. Admission to the show is by invitation and registration only. The general public is not admitted. Show hours will be from 2 to 10 pm on Monday, Nov 14; 11 am to 10 pm on Tuesday, Nov 15 and Thursday, Nov 17; and from 11 am to 6 pm on Wednesday, Nov 16 and Friday, Nov 18.

The atomic power section will support a program of technical papers to be offered by the ASME Nuclear Energy Division. Exhibits in this group of displays are expected to afford answers to many questions regarding applications of mechanical engineering in the practical uses of atomic energy.

Other exhibit material will include equipment used for generation, dis-

(*Continued on page* 232)

U.S. turns "exhibit" reactor over to Switzerland

► THE "ATOMS FOR PEACE" Conference at Geneva closed with the signing of documents turning the U.S. Exhibit Reactor over to Switzerland for research work on peaceful uses of atomic energy. The reactor was built at Oak Ridge National Laboratory.

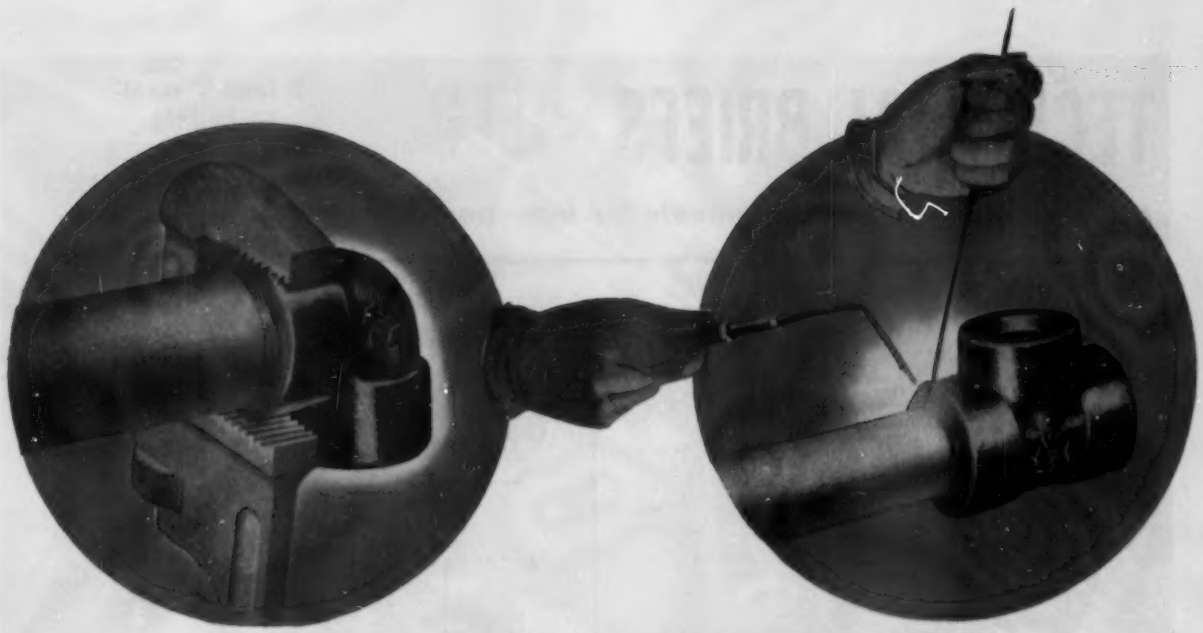
At the signing ceremony, photo above, are, l to r, Walter Boveri, President of Swiss Reactor Corp, Lewis L Strauss, Chairman of U.S. Atomic Energy Comm, Miss Frances Willis, U.S. Ambassador to Switzerland, Prof Paul Scherrer, Chairman of Swiss Comm of Nuclear Research and Williard F Libby, U.S. Atomic Energy Commissioner.

Pulp-grinder motors, largest in U.S., going to Bowaters

► SIX 6000-HP synchronous motors, largest ever applied to single-pulp grinders, are being built for Bowaters Southern Paper Corp, Calhoun, Tenn. by Electric Machinery Mfg Co, Minneapolis, Minn.

The six motors, which are 240-rpm 4000-volt units, are enclosed with air-to-water coolers located at the bottom. The sleeve-type bearings are 14 inches in diameter and 20 inches wide. They are lubricated by double oil rings. Over-all weight of each unit is 45 tons.

Picture above shows first of the six motors after tests were completed. It has already been shipped to Bowaters.



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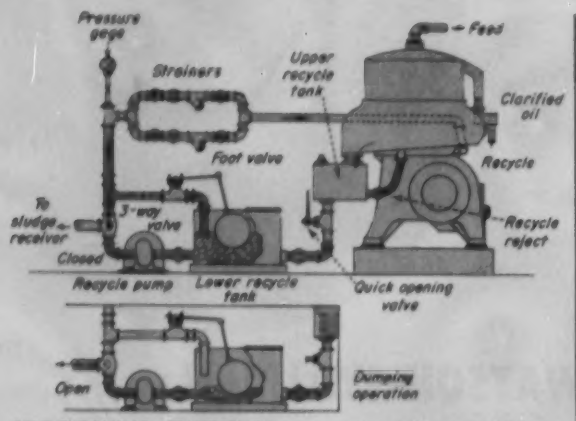
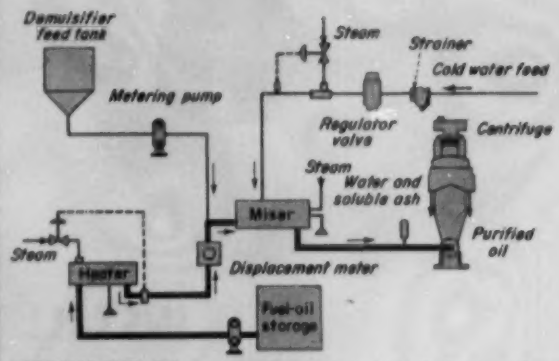


SELF-CLEANING CENTRIFUGE system for residual purification

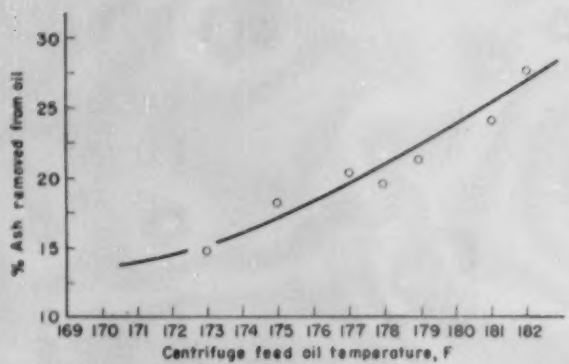


RESIDUAL FUEL OIL water-wash system using tubular centrifuge

CENTRIFUGAL CONDITIONING OF FUEL OIL

FUNCTION OF THE CENTRIFUGE	DIESEL POWER PLANT	DIESEL MOTORSHIP	GAS TURBINES
Removal of entrapped water		●	
Removal of carboids	●	●	●
Deagglomeration of asphaltanes	●	●	●
Water washing of soluble salts			●

FUNCTION OF CENTRIFUGE in conditioning residuals for power



FEED TEMPERATURE and its effect on removal of ashables

Better preparation — key to greater use of residual fuel oils

The preparation of residual fuel for motive power. *By F H Smith, F P Downing and J T Costigan, The Sharples Corporation.*

Success in utilization of residual fuels for internal-combustion engines and gas turbines can only be accomplished by close co-operation between engine manufacturers, oil companies, equipment suppliers, and power producers. Engine companies have been reluctant to guarantee operation of their engines on residual fuels, and it is understandable that the power producers would be equally reluctant to invest in capital equipment without such a guarantee. Oil companies have not been interested in spending money on research to improve consumption of a distress product, and equipment suppliers have by far the least stake in the over-all picture, making their investment in research relatively inadequate.

For this reason, developments have been slow, but during the past ten years use of residual fuels has been recognized as an accomplished fact capable of reducing operating costs as much as 40% and placing engine manufacturers in a preferred position for supplying motive power for industrial and marine service. Municipal power plants and private shipping companies have operated diesel engines on residual fuel for long enough to establish the fact that the testing period is over. From now on literature should be composed of discussions of refinements in operating methods, measurement techniques, and purifying systems. *ASME paper No. 55-OGP-1.*

Aerothermodynamic considerations involved in turbocharging four- and two-cycle diesel engines. *By R Birmann, DeLaval Steam Turbine Co.*

The turbocharged engine is, in effect, a compound engine in which the engine

J-M 85% Magnesia is lightweight . . . easy for workmen to install half-sections on this 10" steam line. Insulation work at the Grace Chemical plant was performed by Young Sales Corporation of St. Louis. Engineering and construction was directed by Foster Wheeler Corporation of New York.

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INDUSTRY'S LONG-TIME standard for temperatures to 600F is still your best insulation buy. For J-M 85% Magnesia provides high insulating value, easy application, long life, initial low cost and minimum maintenance. That's why insulation engineers consistently specify J-M 85% Magnesia for modern installations like Grace Chemical's new anhydrous ammonia-urea plant. That's why it will pay you to specify J-M 85% Magnesia for your new plant or modernization program.

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J-M 85% Magnesia also comes in block form. Here you see it being applied to a vertical drum at a New Jersey petroleum refinery.

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More TECHNICAL BRIEFS

Begins on page 162

itself handles high-pressure end of both compression and expansion, while exhaust-turbine-driven compressor takes care of the low-pressure end. Turbocharger pressure ratio determines division of work between high-pressure and low-pressure components, and value of this pressure ratio governs, to a large extent, values of all engine performance variables.

In this paper, interrelationships between all of these variables are discussed, and curves are presented giving, numerically, the interdependence, one on the other, of turbocharger pressure ratio, thermal loading, specific fuel consumption and turbo-charger combined efficiency, with and without intercooling.

The aerothermodynamic situation of two-cycle engines is treated separately, with emphasis on the all-important flow-handling ability of the engine. This ability is defined by the concept of the "gas change process merit ratio," and, by means of a series of curves, the specific engine air flow is given for different merit ratios and different turbocharger combined efficiencies for a range of turbocharger pressure ratios. Finally, for both two-cycle and four-cycle engines, the importance of good matching between engine air-consumption characteristics and turbocharger air-delivery characteristics is discussed, and as a criterion for this matching the engine operating line, as it appears superimposed on the compressor characteristics curve, is used. *ASME paper No. 55-OGP-10.*

Cetane improver additives for diesel fuels. *By W H Hubner, Ethyl Corp.*

A remarkable increase in use of diesel power has occurred during the past 14 years. This has resulted in a substantial demand for diesel fuel—a demand that has increased six-fold since 1941 compared to a two-fold increase for gasoline, the principal petroleum product. To achieve cetane requirements with available diesel fuels, additives are needed. After exhaustive research, DB-36 amyl nitrate was found to be effective in all types of diesel fuels, regardless of crude source, sulphur content, or refining technique. This paper reviews this development in some detail. *ASME paper No. 55-OGP-12.*

Heat transfer

A new electrical analogue method for the solution of transient heat-conduction problems. *By G Liebmann, Associated Electrical Industries Ltd.*

A new resistance-network analogue method for solution of heat-flow problems under transient conditions is described in this paper. In this method, electrical networks represent difference equations that approximate differential equations governing the problem to be solved. Temperature is represented by voltage, spatial features of the problem by a network of parallel resistances, and thermal constants by series resistances. A solution in steps of time is obtained by successive readjustments of potentiometers supplying voltages to the network. The new method is very flexible, the time interval and thermal constants being adjustable during progress of the work. It can be applied to problems of considerable complexity. One of its outstanding features is its "stability." Accuracies of better than 1% can be obtained. *ASME paper No. 55-SA-15.*

Directions for ordering papers on p 256

Heat transfer to turbulent boundary layers with variable free-stream velocity. *By R A Seban, University of California and D L Doughty, Shell Development Company.*

Local heat-transfer coefficients have been determined for turbulent boundary layer of a two-dimensional, subsonic, air flow over the surface of a flat plate, with air velocity variable over the plate length. The boundary layer, formed with almost constant velocity, was then subjected to a strong acceleration that produced a three- to four-fold increase in free-stream velocity, and after this maximum there was a gradual deceleration of flow. Maximum velocities ranged from 200 to 900 fps.

Use of the results, obtained for a particular kind of variation of velocity, is primarily as a check of methods of predicting heat transfer under circumstances of this type. It is shown that adequate predictions can be made from an analysis based on constant properties, and that the most important element of the analysis is an account of the thermal energy in the boundary layer at any point along the plate. Results are given for constant velocity along the plate, both for a completely turbulent flow and for turbulent flow occurring after natural transition. Heat-transfer coefficients so obtained for the turbulent boundary layer agree best with the prediction of the von Karman analogy. *ASME paper No. 55-SA-68.*

Local and average coefficients of heat transfer for horizontal laminar motion of fluids in a circular tube. *By Charley Scott, Mississippi State College, Glen E Eggleston, Douglas Aircraft Co and W L Sibbitt, Purdue University.*

Local and average coefficients of heat transfer have been investigated experimentally for water, transformer oil, and a "viscosity-increased" water solution flowing in laminar motion through a circular tube with its wall at constant temperature. Simultaneous development

(*Continued on page* 244)

Combustion papers

The International Conference on Combustion, recently held in Boston, Massachusetts and being repeated in London, England this month, is a joint venture of ASME and The Institution of Mechanical Engineers. A large number of papers dealing with combustion make up this Conference. Below are listed some of the titles of papers dealing with subjects of interest to power-plant designers and operators.

Chemical aspects of combustion; Chemical and physical factors controlling the rate of combustion; Scientific principles of combustion and their application; Instruments as applied to the detection of flame failure; Furnaces for low-quality solid fuels; Effect of fuel properties on firing methods; Boiler availability—a commentary; Liquid-fuel firing; Combustion of pulverized fuel for steam generation; Spreader stokers and combustion; Instrumentation of process tubular heaters; High-compression turbocharged spark-ignition gas engines; Combustion in large diesel engines; Combustion in diesel engines with divided combustion chambers; Combustion in dual-fuel engines; Coal-firing for the open cycle gas turbine—a comparison of methods; The use of solid fuel in the gas turbine; Operating experience with combustion equipment in industrial gas turbines.

Only complete sets of the papers are available. Price is $3. Order from ASME, 29 W 39th Street, New York 18, New York.

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Weather-proof and Water-proof qualities are at first glance a distinct advantage in tape which is designed exclusively to meet outdoor conditions. This Tape is free from rubber, thus assuring the user against gradual vulcanization or hardening of the tape through age.

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Acid-proof and Alkali-proof qualities become important in underground work. The viscous, bituminous base of Ankorite Black Water-proof Tape is resistant to the natural acid and alkali solutions found in mine water.

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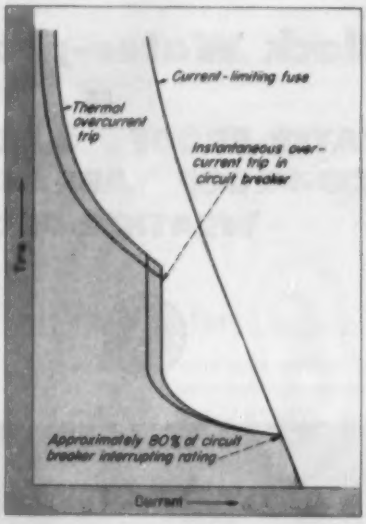
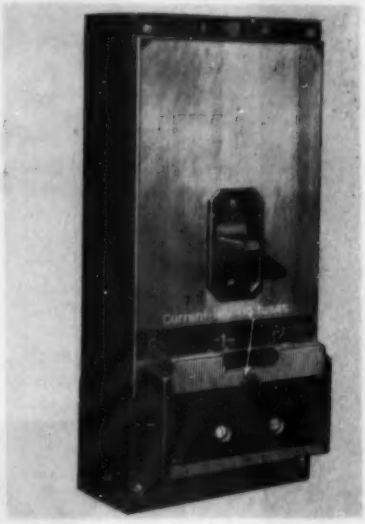
Breaker-fuse unit copes with high short-circuits

Current - limiting fuse combined with standard circuit breaker provides an interrupting capacity of 100,000 rms amperes





1000 • New *Cordon* circuit breaker weds a current-limiting fuse to a standard molded-case circuit breaker—both in a common molded housing no wider or deeper and only a few inches longer than the standard, comparable size breaker. This union makes possible, for the first time, a compact electrical protector with short-circuit interrupting capacity of 100,000 rms amperes with all the operational advantages of a circuit breaker.

Standard circuit-breaker section of the *Cordon* unit contains conventional thermal trip (for minor overloads) and instantaneous magnetic trip (for all faults below extreme short-circuit currents). Thus repetitive action of the circuit breaker is retained and replacement need be made only after major short-circuit faults that exceed normal interrupting rating of the standard breaker.

Current-limiting fuses are designed to assume fault-clearing duty from thermal and magnetic trips at 80% of interrupting rating of the breaker section—at 20,000 amperes in the case of a 25,000-ampere rated circuit breaker.

The compact fuse element, heart of the new unit, is a high interrupting-capacity current-limiting-fuse called *Amp-trap* (see POWER, Oct 1953 p 107; Sept 1955 p 116). Fusible elements are silver links—either notched or perforated—suspended between two copper blocks and packed in a special quartz sand. The silver and quartz—both having the same melting point—fuse simultaneously under currents of short-circuit magnitude. Fused glass, resulting from the melted quartz, provides a continuous dielectric across the fuse breaks to minimize arcing even under unusually high currents.

Amp-trap design is such that short-circuit current is completely interrupted in a quarter cycle. Consequently a current-limiting effect is achieved that materially reduces current passed during a short-current fault. Thus the resulting magnetic stresses—proportional to the square of the current—and also the heat generated by the short-circuit current are kept well within capacity of the breaker. This current-limiting characteristic of the *Amp-trap* permits the conventional molded-case breaker to weather shock of a heavy fault.

Mechanical interconnection between the *Amp-trap* and circuit breaker makes it impossible to damage electrical equipment by operating on two phases when the third phase faults to ground. Each *Amp-trap* contains a spring-loaded plunger that is released when the unit fuses. Plunger in turn sets breaker trip mechanism, opening all three phases.

This feature makes it impossible to reset the circuit breaker without replacing the blown *Amp-traps*. It also eliminates danger of removing fuses under load as mechanical linkage will trip the breaker before *Amp-trap* trip unit contacts are broken.

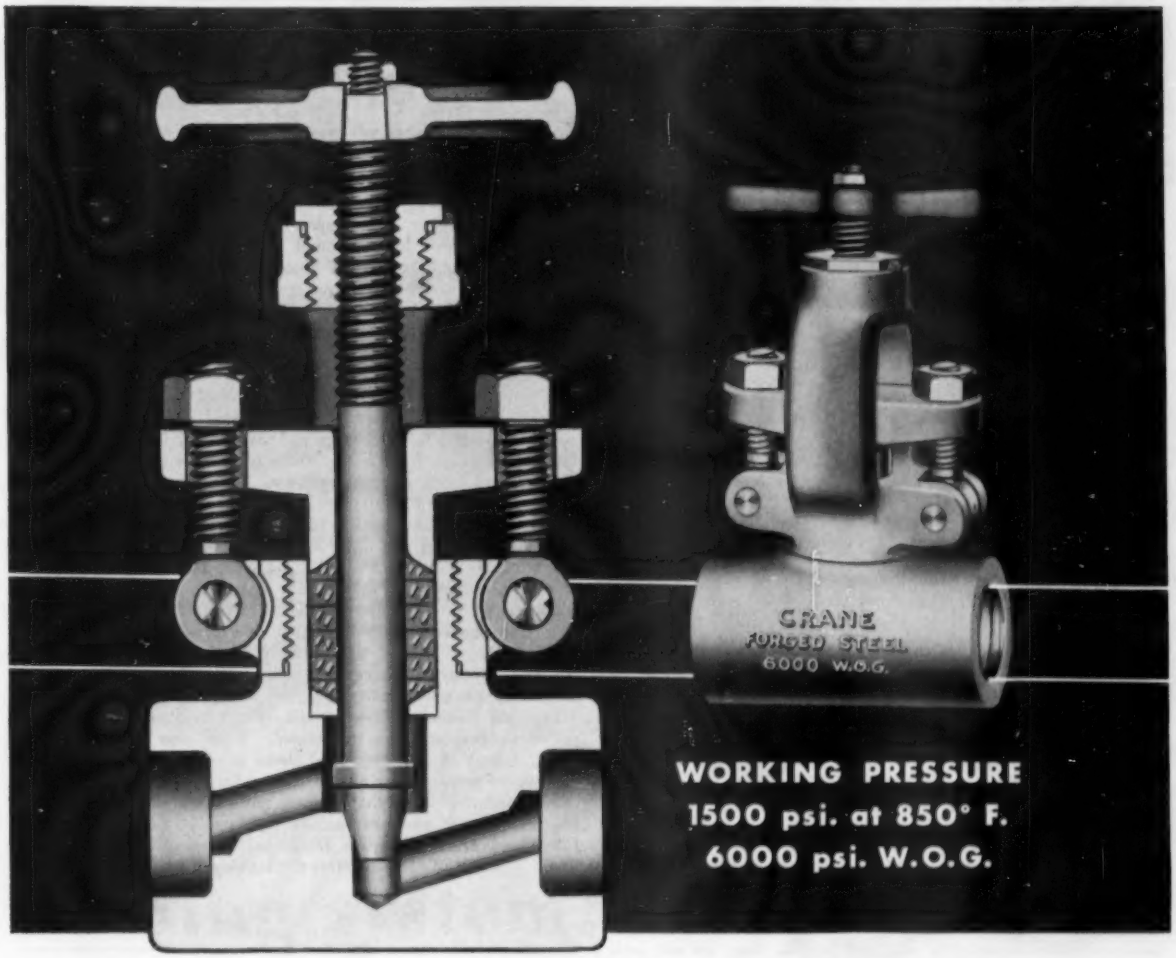
The time it takes to reset a *Cordon* breaker actually indicates magnitude of the fault current. In case of a minor overload, thermal element will open breaker and operator will have to allow bi-metal to cool for a few minutes before being able to reset the breaker. If fault is a major overload, yet less than 80% of standard circuit breaker interrupting rating, operator will be able to reset magnetic trip immediately. In event of high short-circuit current, breaker cannot be reset until blown *Amp-traps* are replaced.

The spring-loaded *Amp-trap* plunger further simplifies process of fault location in the case of short-circuit failure by providing visual indication of the phase that shorted.

Accessibility of the *Amp-trap* trip unit from front of breaker permits fast replacement of fuses after a short-circuit current fault. For rapid return to service after a major fault, entire *Amp-trap* unit can be replaced with a loaded standby trip unit in a matter of seconds.

I-T-E Circuit Breaker Co, Small Circuit Breaker Div, 19th and Hamilton Sts, Philadelphia 30, Pa.

Now Available



New Crane Forged Steel Instrument Valves

Been looking for an exceptionally rugged, compact, and low-priced stop valve for your small hydraulic or high-pressure, high-temperature instrument lines?

Crane has developed it—sizes ¼", ⅜" and ½", in both screwed and socket-welded patterns. It's the all-new Crane Forged Steel Instrument Valve, and you can specify it now for immediate delivery.

Will Handle Many Services

Note closely the over-all design and construction shown above of this new Crane valve. Oversized stuffing box—heavy-duty Crane Exelloy stem with integral disc—bolted gland—swinging gland eye bolts—outside screw and yoke construction—all add up to the high performance and low maintenance you want in a valve for your instrument panels, orifice meters, bypass and gauge lines, regulator leads, and other hydraulic and high pressure/temperature lines.

Literature on Request

These rugged, low-cost stop valves are built for 1500 psi. at 850° and 6000 psi. W.O.G. Construction and materials are job-engineered by Crane experts—backed by a century of quality manufacturing, matchless experience. You'll want complete information on the all-new Crane Forged Steel Instrument Valves. Contact your Crane Representative, or write to Crane Co., General offices, Chicago 5, Illinois—Branches and Wholesalers serving all industrial areas.

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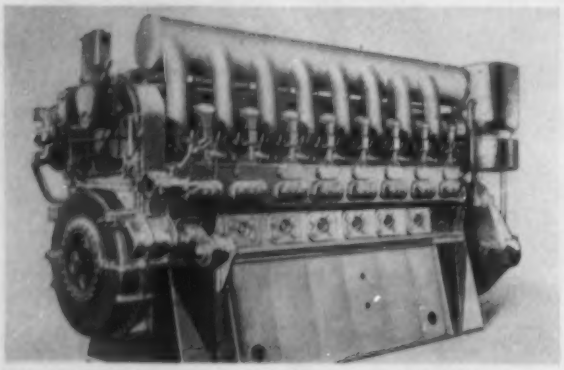


TURBOCHARGED diesel, available in 6, 8, 12, 16 cylinders

CUTAWAY, *left,* shows cast construction of cylinder heads with symmetrical water passages around valves and injector

GEAR TRAIN, *right,* has spur gears with spigot-type journals

Turbocharged 2-cycle diesel engine features lower cost, maintenance

1001 • This *Model 498* engine, as compared with a non-turbocharged unit, shows an increase of 60% in both hp per cu ft of engine volume and hp per pound. Claimed features include (1) lower initial and installation costs per hp (2) fewer working parts per installed hp (3) lower operating costs because of higher efficiency and (4) lower maintenance expense per hp.

The engine, available in 6, 8, 12 and 16-cylinder sizes, has a bore of 8¾ in., stroke of 10½ in. and will develop 175 bhp per cylinder.

A series of engine tests disclose a flat-fuel rate curve from 50 to 100% at any operating speed. At rated speed the fuel consumption is .360 lb per bhp-hr and .380 lb per bhp-hr maximum fuel consumption from 50 to 100% of the hp range. Lube oil consumption is .02 gph per cylinder. Tests also reveal that this engine is free from any appreciable torsional vibrations over the entire operating range. By turbocharging a thermal efficiency of 36% has been attained.

All engine parts are accessible for inspection or removal. The crankcase is designed so that all welds are stressed less than 5000 psi, indicating a generous factor of safety. Removable fretting rings between cylinder liners and crankcase are said to eliminate "wear out" of the crankcase during life of the engine. No coolant water is in contact with the crankcase—thus crankcase corrosion is eliminated.

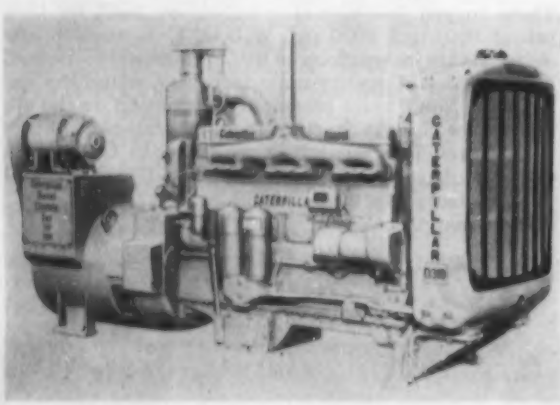
Separate piston cooling by oil spray jets assures that low piston temperatures are maintained. Wrist pins are lubricated by force feed. A hardened steel sleeve is used in the connecting-rod eye to prevent wear on the rod proper.

Manufacturer states that over-all noise level of this engine is less than that of any other unit in its class.

Cleveland Diesel Engine Division, General Motors Corp, 2160 W 106th Street, Cleveland 11, Ohio

For more data on these items, use post cards p 175. Identify your request with item number.

Packaged diesel-electric sets have self-regulated generator



1002 • Feature of these diesel electric sets is a new self-regulated generator—designed and built to match the engine powering it. The new power units are designed to meet needs of applications now served by self-regulated or externally-regulated generators. Featuring close voltage regulation, they provide steady voltage from no load to full load.

During initial installation the "terminal" voltage and voltage "droop" can be adjusted to meet special conditions of the particular application. After that, adjustments are locked and no further regulation is necessary.

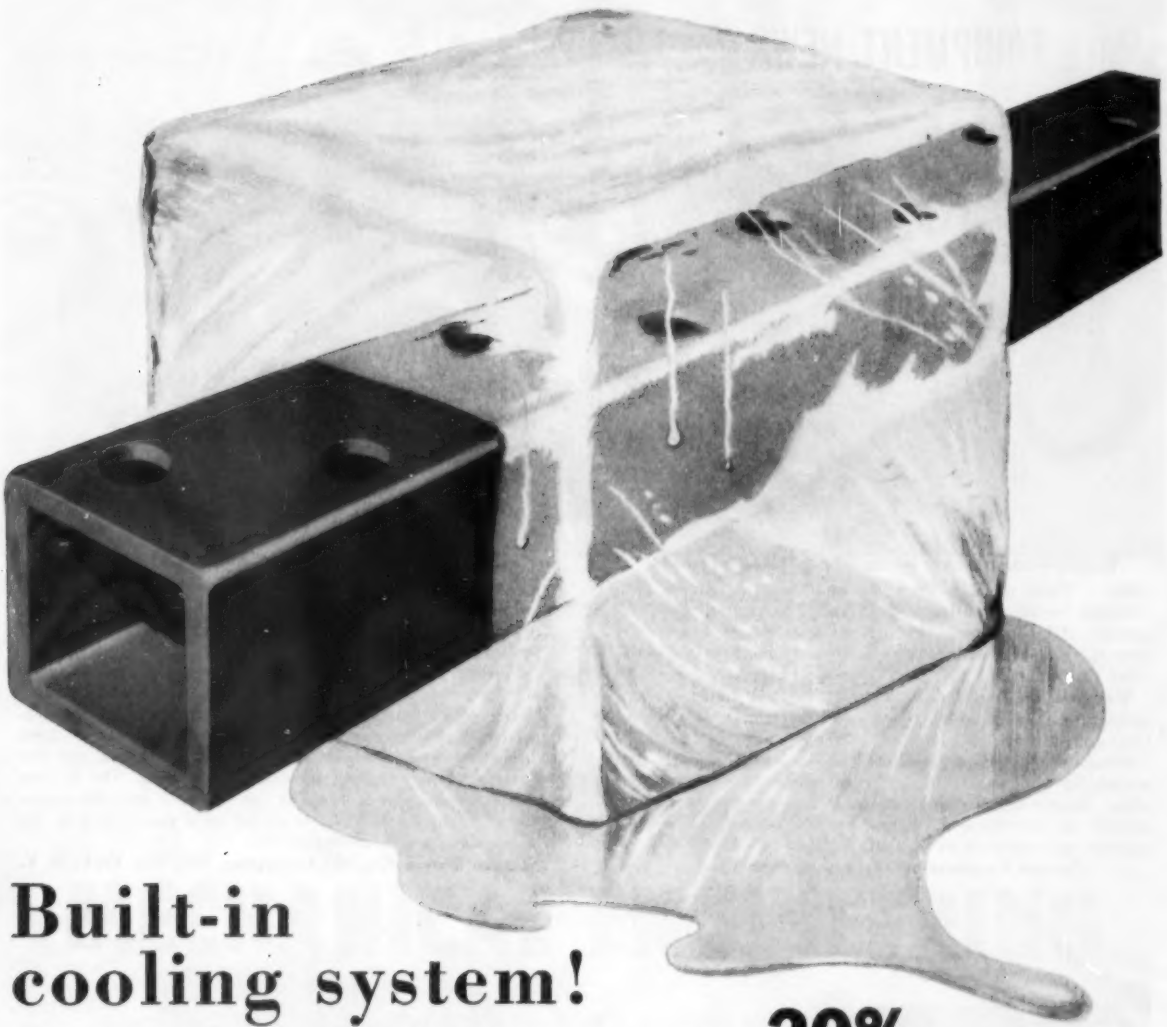
The sets are easily installed—no complicated switchgear or external voltage regulators are needed. They can be paralleled with most any type or make generators now in use.

Generators are smaller in size than previous models. Leads can be taken from the side, back or top without affecting machine width. Reduction in frame size, disk-type coupling and top-mounted exciter results in a shorter over-all power package.

Heavy-duty, single-bearing and close-coupled construction tend to simplify maintenance. The single bearing is easily accessible and is lubricated from a grease reservoir that requires filling only once a year.

The generator uses a compact static-regulator that contains no moving parts. Manufacturer states that the complete generator has been designed and built to last the life of the diesel engine matched to it. Further data available on request to manufacturer.

Caterpillar Tractor Company, Peoria 8, Illinois



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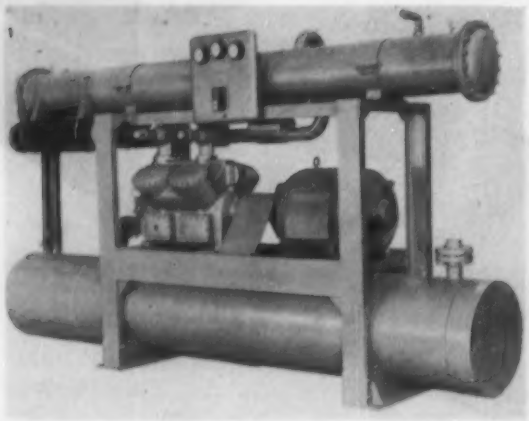
More EQUIPMENT NEWS

Begins on page 166



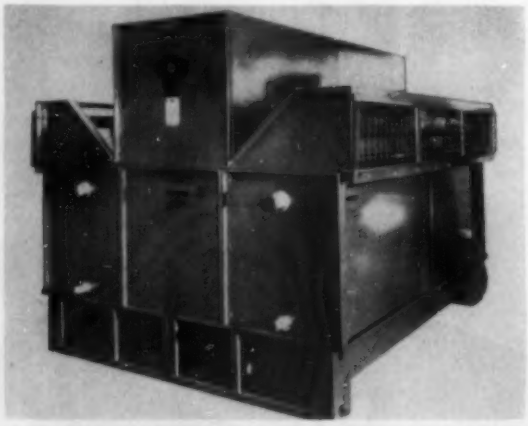
Water-cooling machines are packaged units

1003 • These units, ranging in size from 5 to 125 hp, are designed for air conditioning and process refrigeration installations. All components of the refrigerating system—compressor, condenser and cooler—come as a single unit, piped, filled with oil and a holding charge of refrigerant.

Machines are mounted in a structural-steel frame. After positioning the equipment a few water and electrical connections complete the installation.

Minimum space is accomplished in the smaller models by assembling components in a vertical plane—one above the other. Larger capacity units resemble the side-type assembly peculiar to centrifugal machines. Further information is obtainable on request to the manufacturer.

Carrier Corporation, Syracuse, New York

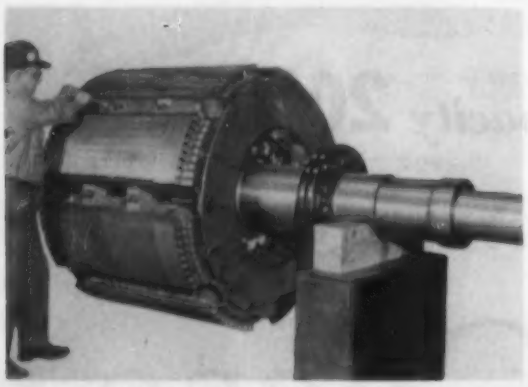


Cool ng equipment for industrial processes

1004 • Equipment is designed to provide water saving in industrial cooling and to give close control of temperatures—within 2 F. It cools by evaporation and obtains temperature control by modulating the use of outside air.

Fluid to be cooled flows through two coil sections, both of which are kept drenched with a water spray. A portion of this water evaporates—balance is recirculated by a pump. Air enters through dampered intakes above coils, travels down through sprays, enters a central plenum between the two sections. Here, entrained moisture is eliminated. The air then moves upward and a propeller fan ejects it into the atmosphere. Fluid in the coils is cooled to a point close to the atmospheric wet-bulb temperature.

Niagara Blower Co, 405 Lexington Ave, New York, N. Y.

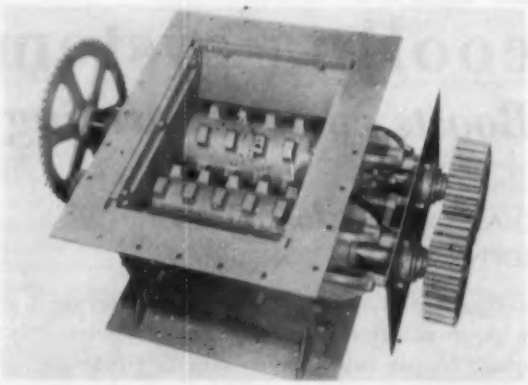


Cage winding for large synchronous motors

1005 • *Flexible finger* cage is designed to eliminate cage failures on large motors with severe starting requirements. Damper bars are brazed to a radically different end ring that has 3-way "give" against expansion due to heat, plus high heat dissipating capacity. Result: Even on slow or repetitive starts there are no heavy stresses on damper bars that might cause failure or burn-out.

Fingers are also flexible in a radial direction, preventing expansion from transferring radial forces to the damper bars. End ring proper is flexible in a circumferential direction to allow for thermal expansion of the ring.

Electric Machinery Mfg Co, Minneapolis 13, Minnesota



Double-roll clinker grinder reduces ash, slag

1006 • Double-roll construction is claimed to have following advantages over single-roll types: (1) handles larger clinkers (2) desired maximum size of end product is maintained (3) less wear because sizing is accomplished by applying pressures at a few points rather than by attrition.

Unit handles wet or dry material and can be operated with rolls submerged. Bearings are mounted outside shaft stuffing boxes—free from water, grit damage. When handling dry material, compressed air sweeps through glands and bearings to prevent entrance of grit. With wet material, water is used. Unit reduces clinkers to 2-in. maximum dimension.

The Allen-Sherman-Hoff Co, Wynnewood, Pennsylvania

For more data on these items, use post cards p 175. Identify your request with item number.

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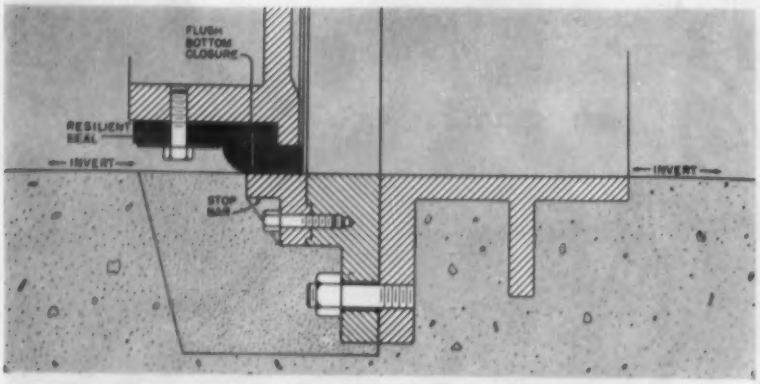
Begins on page 166



Bottom-seating sluice gate improves flow

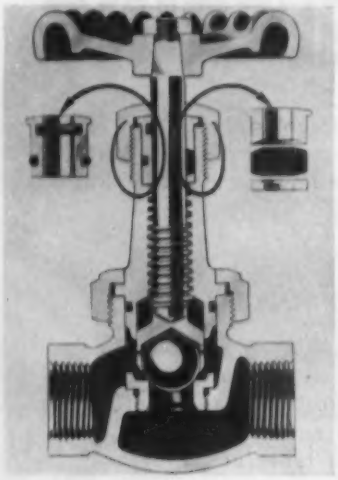
1007 • Frame of this unit has been lowered so that opening is flush with adjacent chamber floors or with natural bottom floorline. The gate seats flush with the invert. It is secured in its closed position by bronze wedges on top and sides only, holding it tight against the frame. Unit carries a heavy strip of flexible Neoprene on the bottom of the gate disk. When gate is closed this Neoprene flexes and gives a "cushion-closing" seal that compresses on the stop bar.

Because of flush-bottom closure arrangement there is less turbulence at bottom where head is greatest so smoother flow is possible. There is no trough to accumulate silt.

Rodney Hunt Machine Company, Orange, Massachusetts

Ouch . . . we muffed this one . . . but good!

Items below were run incorrectly in August, p 162. Case of right copy, wrong photo—or was it vice-versa? Here's how they should have looked.



Bronze ball valves

806 • Valves use four O-rings as seals to close all outlets for leakage, manufacturer states. Valve stem is sealed at top with one O-ring, stuffing box on outside with another, bonnet with another and one is placed under the seat. Optional steam packing is used to change valve from one service to another.

Carpenter Valves Corp, 6723 Denison Ave, Cleveland 2, Ohio

Manual reset valves

807 • These valves are designed for emergency safety services requiring quick, positive action. They may serve as a safety shutoff in either liquid or gas fuel lines, as a safe open valve for steam or foam fire-snuffing systems, or to shut pipelines that indicate a line break by loss of pressure.

Black, Sivalls & Bryson, Inc, 7500 E 12th St, Kansas City, Mo.

Safety shutoff valve

1008 • Valve shuts off fuel oil on gasoline or diesel engines in case of low oil pressure, high engine temperature, overspeed, low voltage or other abnormal conditions. The valve is opened manually and under normal operating conditions will remain open. In event of abnormal condition, it is energized by the respective control device closing the valve and shutting off fuel supply to the engine. Valve remains closed until manually re-opened. Unit can also be used for stopping the engine with a remotely-located pushbutton. Flow capacity of the ¼-in. pipe size is 25 gph at a low pressure drop. Valves with larger flow capacities are available.

Automatic Switch Co, 391 Lakeside Ave, Orange, New Jersey

Pressure, temperature pilot

1009 • Pilot is applicable for pressure ranges from 0-15 to 0-10,000 psi and 0-30 in. H_2O and 0-30 in. Hg vacuum. Pressure-sensing elements are available in phosphor bronze, beryllium copper or stainless steel.

Temperature ranges are from –40 to 1000 F, with mercury-actuated armored capillary temperature-sensing element available with plain bulb, union connection or union connection with separable socket. Full details on request.

A W Cash Co, PO Box 551, Decatur, Illinois

Diaphragm motor valves

1010 • Improved units are available in direct acting, *Series 657*, or reverse acting, *Series 667*, construction. Units have a bolted-clamp type stem connection allowing stem adjustment of 50% of total travel in either direction. Manufacturer states that it will not shake loose from vibration or rotational inner-valve forces. It can be disconnected in the field without damage to the stem.

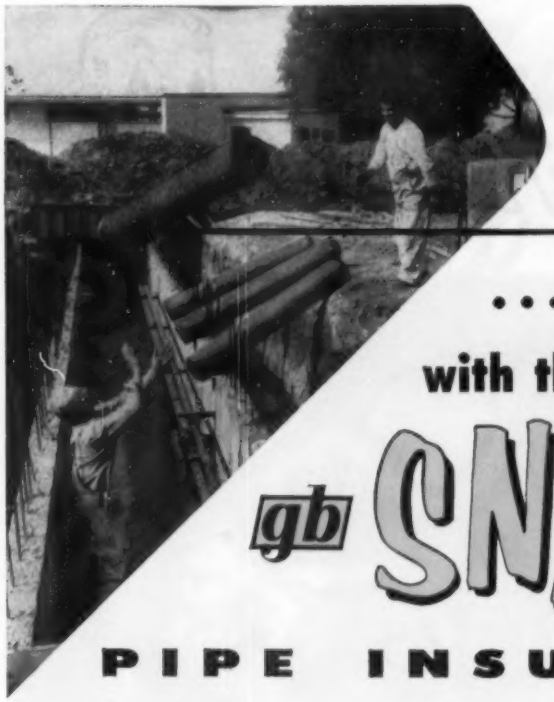
Diaphragm casings are of drawn steel; yoke is hi-tensile iron. Stuffing box contains *Teflon* packing.

Fisher Governor Company, Marshalltown, Iowa

For details on these items, use post cards p 175. Identify request with item number.

CHECK THESE TOO . . .

Remote-handling device . . . . . p 180
Tube-piloting device . . . . . p 180
Control valve operator . . . . . p 182
50-hp steam generator . . . . . p 182
Dust collector . . . . . p 184
Mechanical seals . . . . . p 186
Electrical contact burnisher . p 186
Explosion-proof panelboard . p 190
Spindle-roll drive coupling . p 190



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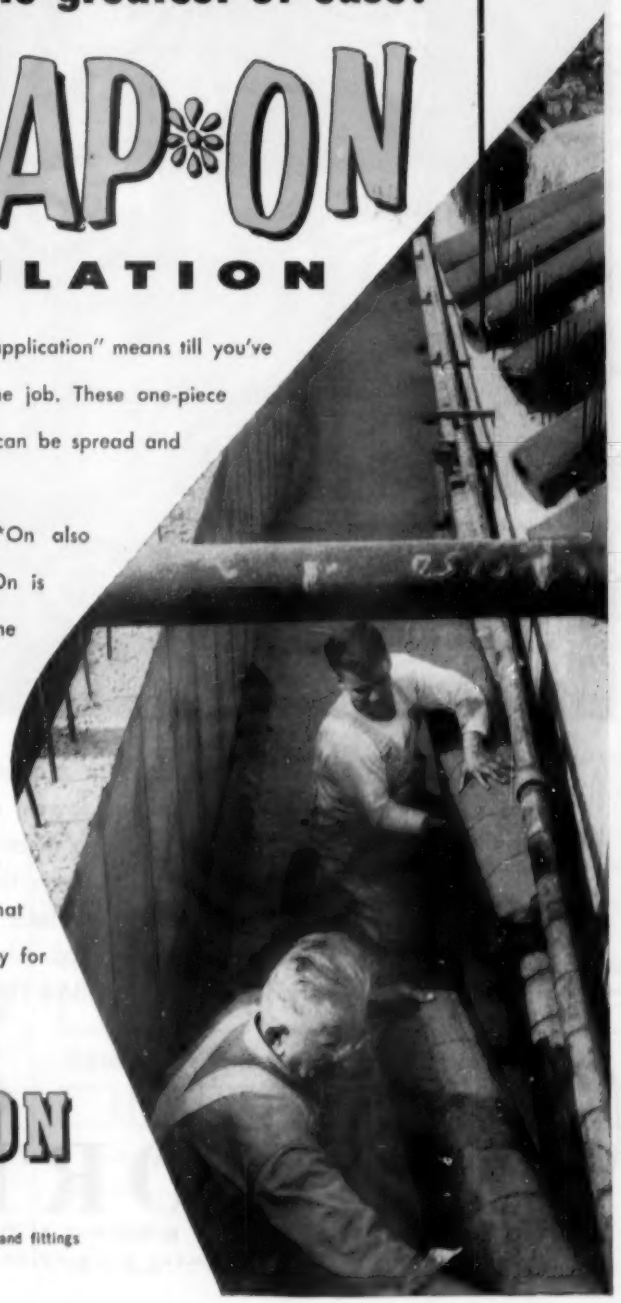
Add to these time-saving conveniences the fact that G-B Snap*On delivers maximum thermal efficiency—*more* heat savings per insulation dollar. Consider, too, that Snap*On is as *permanent* as glass itself. Then write today for the full story on this revolutionary pipe insulation!



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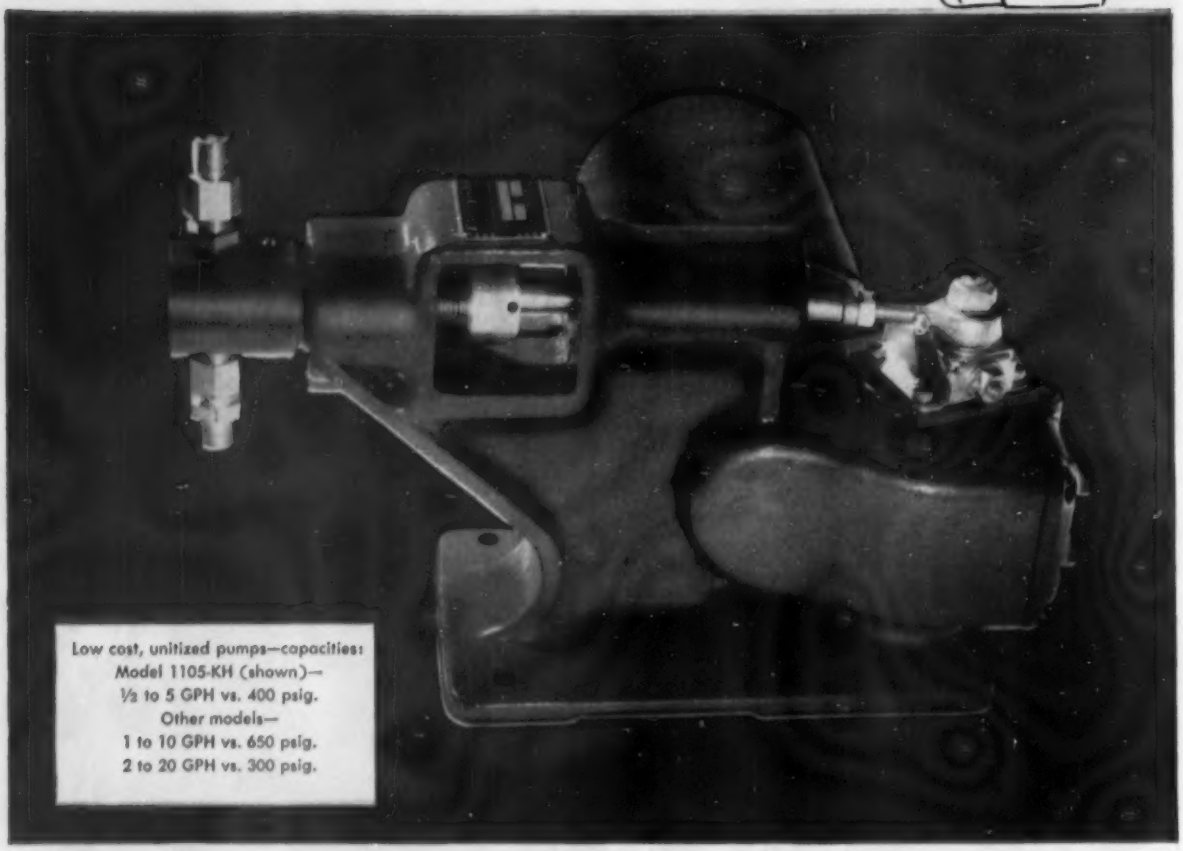
Low cost, unitized pumps—capacities:
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BOILERS AND AUXILIARIES

1 **Generators,** forced recirculation, for high-temperature water heat-distribution systems are described in 10-p bulletin 700. Includes specific features, cites advantages of high-temperature water systems. The International Boiler Works Co, Palm St, E Stroudsburg, Pa.

2 **Packaged steam boilers** with capacities from 75 to 750 hp, pressures from 15 to 350 psi. Illustrated 4-p bulletin contains installation photos, cutaways. Johnston Brothers, Inc, Ferrysburg, Mich.

3 **Combustion control.** Complete automatic systems for oil-, gas- or coal-fired boilers described in 24-p bulletin E-104. Includes photos, full page diagrams. Reliance Instrument Manufacturing Corp, 196 Glen Cove Ave, Glen Cove, Long Island, N. Y.

★ **Hot-water heating.** Eight-page technical bulletin 923 is concerned with problems of large-scale water heating, such as encountered in commercial laundries. Includes data on *Iso-therm* system that permits a relatively small boiler to handle large, intermittent hot-water loads. ★Available to plant engineers by requesting direct from Fred H Schaub Engineering Co, 2110 S Marshall Blvd, Chicago 23, Ill.

4 **Condensation-return units** for heating systems with edr ratings from 300 to 10,000 and pressures to 80 psi. Illustrated 4-p bulletin describes single and twin-pump models, for returning condensate to two boilers or when used with a single boiler, to provide a built-in standby pump. Aurora Pump Division, The New York Air Brake Co, Aurora, Ill.

ELECTRICAL EQUIPMENT

5 **Emergency lighting equipment.** Complete line of battery-powered units are described in 8-p bulletin 5736. Contains diagrams, charts, specs useful to anyone connected with the planning of emergency lighting installations. Exide Industrial Division, The Electric Storage Battery Co, Box 8109, Philadelphia 1, Pa.

6 **Transformer power** and lighting connections are explained and diagramed in 8-p bulletin CB-102. Contains data on the more common single-phase applications. Kuhlman Electric Co, Bay City, Mich.

7 **Pictorial directions** for making all types of cable joints in neoprene-jacketed durasheath cables are contained in pocket-size booklet. Prepared for use by engineers and cable splicers. Anaconda Wire & Cable Co, Cable Accessories Dept, 25 Broadway, New York, N. Y.

VALVES, FITTINGS, SPECIALTIES

8 **Diaphragm control valves,** *Series 400.* Data includes actuator and body specs, flow characteristics, dimensions for double-seated, single-seated and 3-way types. Four-page specification sheet 429. Minneapolis-Honeywell Regulator Co, Industrial Division, Wayne and Windrim Aves, Philadelphia 44, Pa.

9 **Balanced valve regulators,** high and low pressure, are outlined in illustrated 36-p bulletin 1094. Consideration of regulator problems and solutions are presented by use of full pages of text with a facing page of cross-sectional schematic drawings to each of 16 distinct gas-regulation situations. Meter and Valve Division, Rockwell Manufacturing Co, 400 N Lexington Ave, Pittsburgh 8, Pa.

10 **Expansion joints,** *FlexoDisc* units, are subject of 8-p bulletin 51. Contains photos, sectional views, features, applications. Croll-Reynolds Engineering Co, Inc, 17 John St, New York 38, N. Y.

11 **Inverted bucket traps** for pressures to 400 psi and temperature to 500 F. Illustrated 4-p bulletin 230 contains full specs. The Clark Manufacturing Co, 1830 E 38th St, Cleveland 14, Ohio.

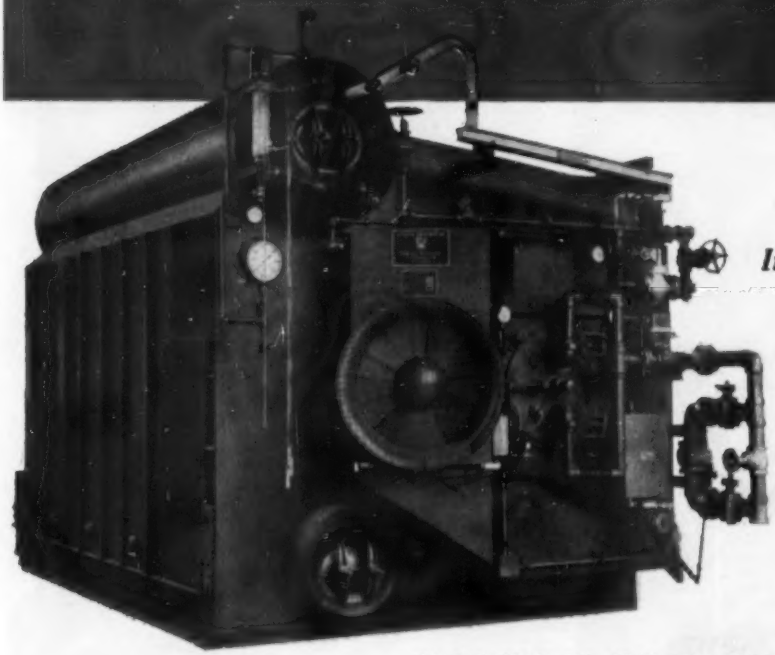
(*Continued on page* 240)

Edwards'

Power a McGraw-Hill Publication

15 YEARS EXPERIENCE

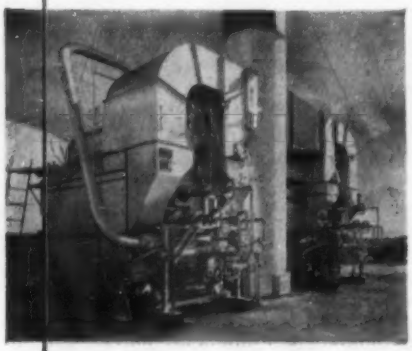
in packaged steam generators



In 1940 the original water-tube packaged steam generators —two Foster Wheeler units— were installed for oil field drilling operations.

New Foster Wheeler Series AG-100 Packaged Steam Generator.

Two FW packaged boilers—the first ever offered to industry—were installed in 1940 and are still in service delivering low-cost steam.



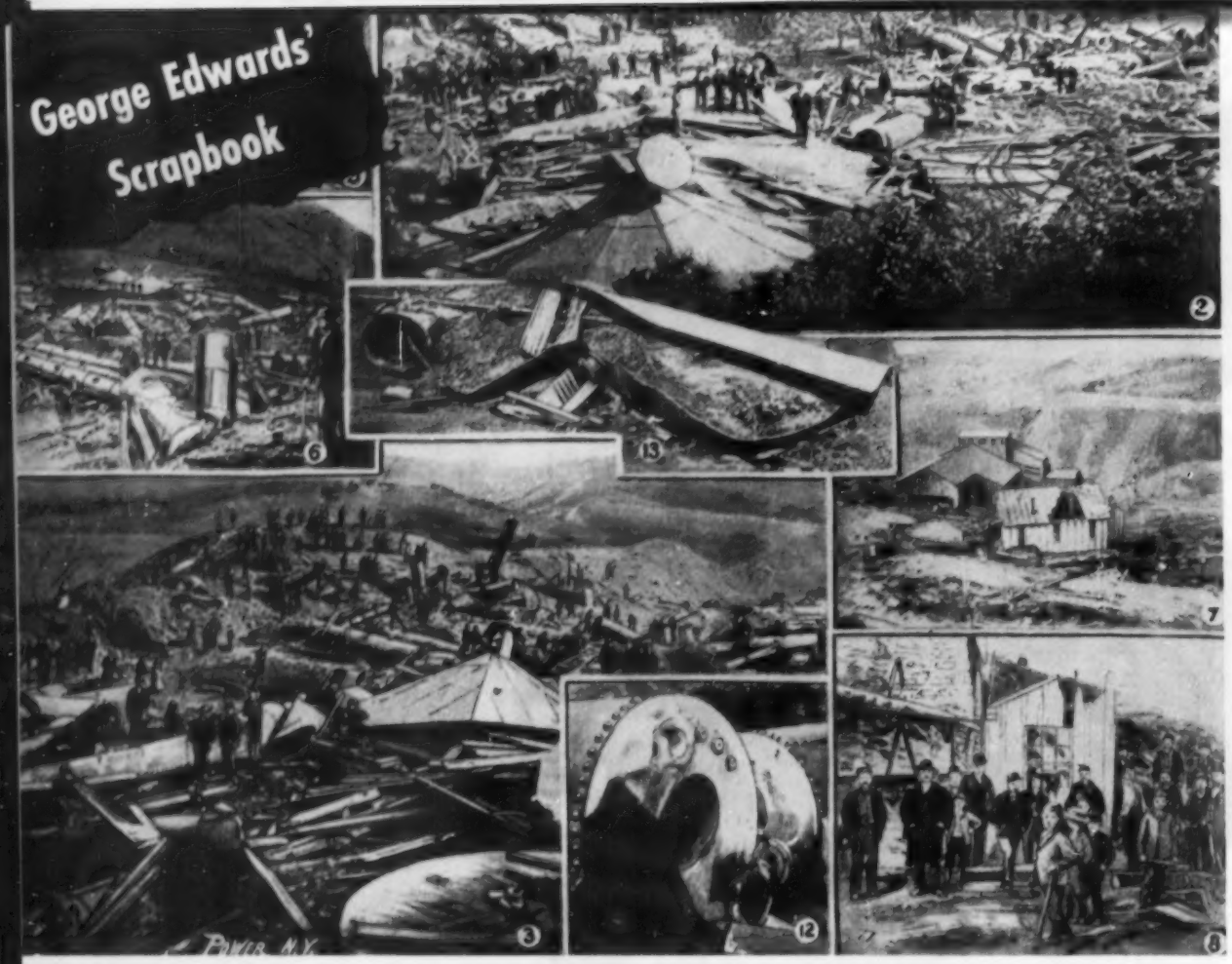
Now, with many successfully operating packaged units in service for processing, heating and generating, backed by 60 years experience in the power industry, Foster Wheeler offers the new "Series AG-100".

The new Series AG-100 shop-assembled water-tube steam generator is supplied for capacities from 10,000 to 46,000 lb steam per hour for oil or gas firing. It provides such significant advantages as baffled steam-collecting internals, the most efficient boiler surface arrangement, tangent furnace side wall and roof tubes which minimize refractory maintenance and provide cool operation, greater adaptability and accessability.

For more detailed information, write for new catalog PG-55-3, *Foster Wheeler Corporation, 165 Broadway, New York 6, New York.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.



Chain reaction back in 1894?

► YOU READERS will be interested in this sensational item from a November 1894 issue of POWER. Illustrations show what happened when one boiler shell let go, causing a chain reaction that exploded 27 of the 36 shells in the boiler house. Five people were killed, others seriously injured.

Boiler house of Henry Clay colliery was in the side of a mountain at Shamokin, Pa. Directly in front of the boilers was a large bank of coal dust and slack, known as culm, and used for firing the boilers. Only five died because the exploding boilers were projected into this bank. Had it not been there the violent blast would have blown units over into the valley where one hundred men and boys were working.

The explosion was so forcible that one 36-in.-diameter shell was driven into the culm its full length of 40 ft, although the shell's head remained intact.

In battery of 36 plain cylindrical boilers, each was 43 ft long, 34 in. dia and from ¼ to 5/16 in. thick. Shells were single riveted in both longitudinal and circumferential seams, with ⅝-in. rivets, pitched at 2 in. The shells were set in nests of three to a boiler. They rested on the wall at front and rear, were supported near the end by cast-iron arches.

Feedwater entered the rear of boilers through a 2-in. pipe, extending 16 ft inside. Each boiler had a check valve on the feed line, and one globe valve serviced a nest of three boilers. Each nest of three drums had one common-lever safety valve. In the place of gage glasses each shell had three try cocks.

It was the duty of a "water boss" to see that the water supply was "properly regulated." Water taken from the town supply was stored in wooden tanks outside the boiler house. Feedwater was pumped into two shorter boilers, where steam heated it to 180 to 200 F.

Battery was worked continuously day and night at 95 to 100 psi. There was 110 psi at 7.30 am when the boilers exploded just as the day shift took over. On the western end, five nests containing 15 boilers exploded. Next, three nests of nine were skipped. Four nests of 12 shells on the other end let go with a tremendous fusillade. That completed what was to that time the largest explosion on record, at least in the number of boilers involved. (If any of you readers know of a worse boiler explosion, please write me about it.)

One piece of boiler drum plunged through the side of the engine house. It struck and broke the cast-iron drum of the hoisting engine, then cut the wire cable. After passing out the end of the engine house, it carried away half the nearby lamp house. A second piece of drum shot entirely over a high hill and landed a quarter of a mile away.

George Edwards
Engineer

Write for the Klinger Master Catalog, which describes the complete range of Klinger products.

First in 1886
Foremost Today

"KLINGERIT," original compressed asbestos sheet packing, was first manufactured over seventy years ago and is used to-day in ships and industry and power plants all over the world. It resists the action of steam, hot and cold water, hot and cold oils, petrol, benzine, the by-products of the coal industry, most acids, and chemicals in general. It withstands the highest pressures and temperatures, and will not burn, disintegrate or squeeze out. It is available in thicknesses from .008" to ¼" and in sheet sizes up to 240" x 96". It can also be supplied in the form of ready-cut gaskets, and with graphited or non-graphited surfaces.

stands up to every test!

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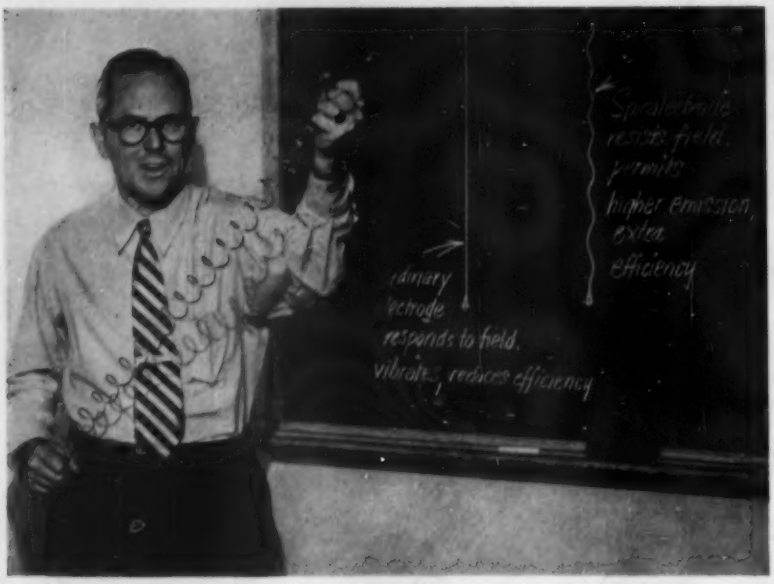
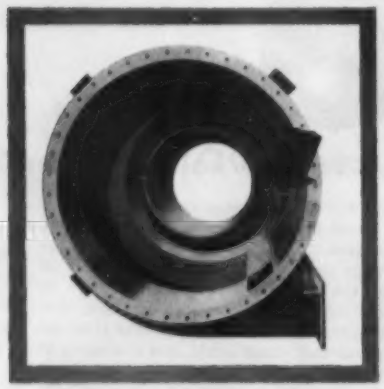
G/5/55/J

How Buell's Unique Spiralectrodes deliver

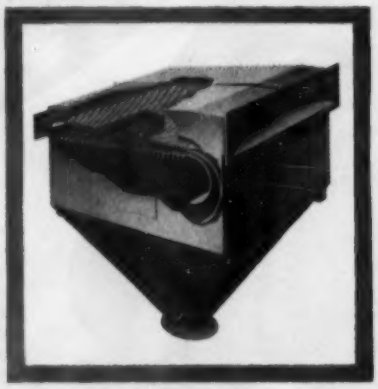
EXTRA DUST COLLECTION EFFICIENCY!


Spiralectrode resists field, permits higher emission, extra efficiency
ordinary electrode responds to field, vibrates, reduces efficiency

Coupled with the unique spiralectrode feature is Buell's Continuous Cycle Rapping—the most effective mechanism yet developed for dry dust precipitation. Completely eliminates puffing, keeps electrodes constantly clean. Re-entrained dust is minimized, peak efficiency is maintained.



Buell Cyclones also deliver extra efficiency, due to exclusive shave-off which harnesses double-eddy and puts it to work!



Buell's Low Resistance Fly Ash Collector combines top efficiency with low draft loss, for natural or forced draft installations.

For the complete story behind Buell's *extra efficiency*, write Dept. I 0
Buell Engineering Company, 70 Pine Street, New York 5, N. Y.

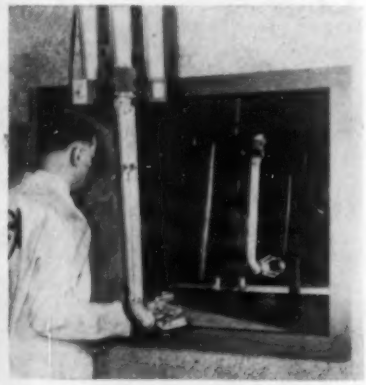
buell

MECHANICAL ELECTRICAL

Experts at delivering Extra Efficiency in
DUST COLLECTION SYSTEMS

More EQUIPMENT NEWS

Begins on page 166



Remote-handling device

1011 • Device is used for handling radioactive materials in nuclear research. Previously manufactured on a made-to-order basis, they are now being produced in quantity. The device has a "slave" wrist action that practically duplicates human wrist motion. It allows operator to perform highly complex hot-cell operations with relative ease and complete safety, according to manufacturer. Unit can handle weights to 30 lbs. It is made in a variety of tube lengths to fit shielding walls for both high- and low-level hot cells. The manipulator has a "Z" motion of either 36 or 39 in. and a full slave arm length of approximately seven feet.

Available in both left- and right-hand models, each unit includes an interchangeable general-purpose tong and through-wall tube shielding. Further data on request.
AMF Atomics Inc, 261 Madison Ave, New York 16, New York

For more data on these items, use post cards p 175. Identify your request with item number.

Tube-piloting device

1012 • Device is used for replacing tubes in condensers and heat exchangers. Consisting of a hardened steel nose with a replaceable nylon brush attached, it pilots tubes through the tube sheet and tube-support plates. The brush fits snugly in end of the tube, centering and holding the pilot firmly in place. It is removed from tube by a slight twist. The brush also cleans the tube where it will be rolled. Pilots are made for tubes 1¼ in. and smaller.
Elliott Co, Jeannette, Pa.

Lubricated plug valve

1013 • Unit is designed for 200-lbs oil-water-gas or 150-lbs steam working pressure. It is available in straight-way, 3- or 4-way and multiple-port types with either 100% pipe area or venturi (restricted flow).

Manufacturer states that this valve affords (1) positive h-p distribution of lubri-

On the Trail of Trouble!

This auto plant had conveyor belt trouble. A Socony Mobil man cured it—saved $1,300 per hour!

Grease spots plagued this large felt mill. A Socony Mobil man ended them—saved $10,000 a year!

These coal miners kept breaking down. A Socony Mobil man stopped this—saved $8,720 annually!

This Flying Red Horse "Sleuth" can solve your problems, too!

His name may be Smith or Jones or Brown. He may be tall or short—blonde, brunette or redhead. But, in each case, he is a master "sleuth"—skillfully trained to track down the culprits that may be robbing your plant of production, material, money.

He is your Socony Mobil man—a lubrication expert who has solved thousands of mystifying cases of trouble in industrial plants. And he has saved plant owners literally millions of dollars with his solutions.

His exploits, in case histories like those reproduced here, are well worth reading—give clues to how he may save money in *your* plant. Now you can read more about him in a special issue of our magazine—"OIL POWER"—just off the press. It will pay you to get a copy. Just write: Socony Mobil Oil Company, Inc., 26 Broadway, New York 4, N. Y.

SOCONY MOBIL

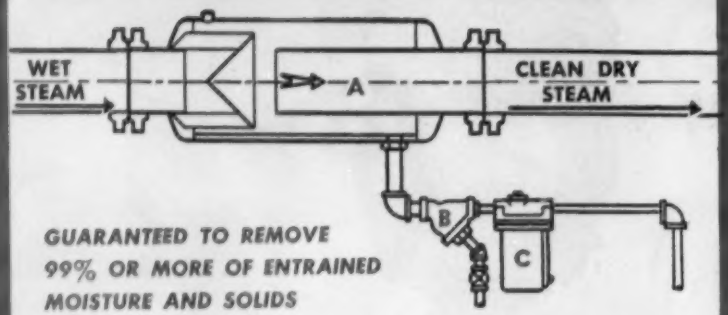
Correct Lubrication

FIRST STEP IN CUTTING COSTS

SOCONY MOBIL OIL CO., INC., and Affiliates: MAGNOLIA PETROLEUM CO., GENERAL PETROLEUM CORP.
Formerly Socony-Vacuum Oil Company, Inc.

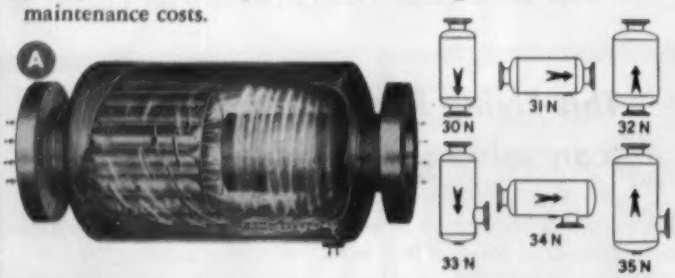
NOW—

The driest, cleanest steam available, is yours with this Wright-Austin equipment

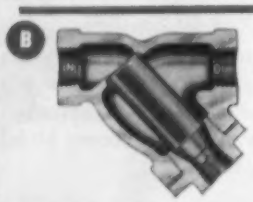


GUARANTEED TO REMOVE 99% OR MORE OF ENTRAINED MOISTURE AND SOLIDS

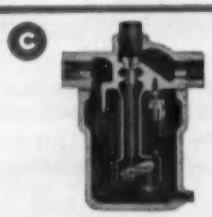
Live steam containing condensate, boiler compound, scale and other foreign matter is detrimental to equipment and is costly to super heat. These Wright-Austin accessories are engineered to give you maximum purification, resulting in lower fuel and maintenance costs.



This Wright Austin separator employs centrifugal force to remove impurities from steam, air or gas flow. The Type 31N, as well as other Models shown, are light weight, compact and sturdily constructed according to the ASME Code.



Foreign matter drains to Wright-Austin "Y" Type strainer which catches solids. These are periodically blown out by opening drain valve.



Condensate flows through strainer to Wright-Austin "Airxpel" Bucket trap. This unit automatically drains condensate as collected.

WRITE FOR NEW CIRCULAR 506-A

WRIGHT-AUSTIN COMPANY

3245 WIGHT STREET • DETROIT 7, MICH.

More EQUIPMENT NEWS

Begins on page 166

cant over the entire sealing surface (2) a self-freeing plug to prevent sticking and (3) the ease of operation of a cylindrical plug valve. Full data in reference book 39-5, obtainable on request to manufacturer.

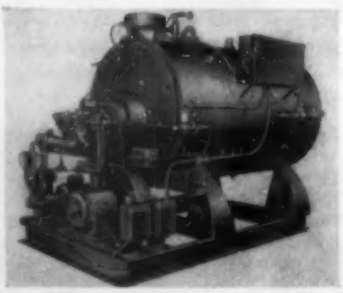
Homestead Valve Manufacturing Co, Coraopolis, Pennsylvania

Control-valve operator

1014 • Self-contained electro-hydraulic unit eliminates need for air supply and compressor systems in operating controllers for process variables such as pressure, temperature and flow. Designed to position conventional slip-stem control valves, see photo, this new controller uses hydraulic force developed by a self-contained pumping unit supplied by 115 or 230-v electrical power. Incompressibility of the hydraulic fluid permits positive positioning of the valve against greatly varying stem thrust thus overcoming valve "flutter" and accomplishing more accurate control. Positioning accuracy is established by a feedback system. Details on request.

Manning, Maxwell & Moore, Inc, Industrial Controls Division, Stratford, Connecticut

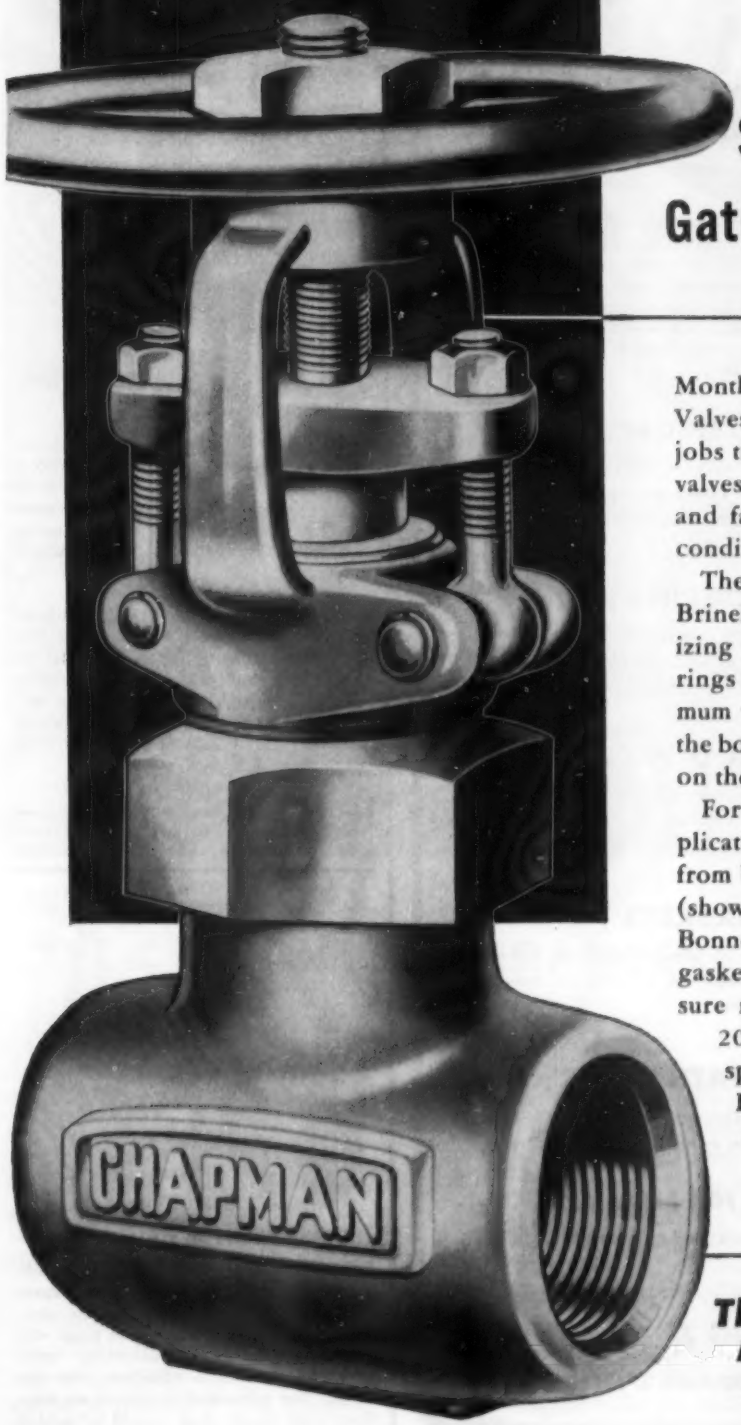
For more data on these items, use post cards p 175. Identify your request with item number.



50-hp steam generator

1015 • Unit, designed to burn No. 4 oil, can be installed in 20-sq ft of floor area. It requires 4-ft 8¼-in. of head room. It is expected that multiple installations of this boiler will prove profitable in metropolitan areas and in plants that experience wide variations in steam load. No cement founda-

Chapman List 960



...for EVERY Small Forged Steel Gate Valve Application

Month after month, Chapman List 960 Valves deliver the goods on more different jobs than any other small forged steel gate valves. And maintenance charges are few and far between even under the toughest conditions.

The wedge gate faces — hardened to 800 Brinell by Chapman's exclusive Malcomizing process — won't seize or gall. Seat rings are hardened stainless steel, for minimum wear, and are easy to replace. Also, the bolted follower has no exposed threads on the yoke to corrode.

For every small forged steel gate valve application, specify Chapman List 960. Sizes from ¼" to 2", either rising stem with yoke (shown) or rising stem with inside screw. Bonnet joint is ground metal-to-metal or gasketed, depending on application. Pressure range is from 380 psi at 1000°F to 2000 psi at 100°F. For higher ratings, specify List 990.

List 960 is made in various alloys and combinations of alloys as listed in Catalog No. 10. Write for your copy today.

The CHAPMAN Valve Manufacturing Company
INDIAN ORCHARD, MASSACHUSETTS

BELMONT PACKINGS

Service conditions are constantly becoming more extreme. The success or failure of a piece of industrial equipment is many times dependent upon whether or not it can be properly sealed against loss of pressure, liquids or gases. Belmont for over sixty years has kept pace with the ever changing demands, offering a wide scope of packing materials to satisfactorily meet the toughest services. You can get them ALL from ONE SOURCE of SUPPLY. Get in touch with your nearest stocking Belmont distributor or mail us your specifications. Write for new condensed catalog #54.

BELMONT "TEFLON"

For corrosive liquids—furnished in sheets, gaskets, rings, tape, plastic, molded bars and sleeves, extruded rods, spiral shapes, blue asbestos and white asbestos suspensoid.

BELMONT "O" RINGS

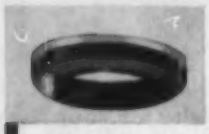
Made to close tolerance from synthetic and natural rubber, "Teflon", Silicone, for dynamic and static seal applications working against air, oil, steam, water, acids.

BELMONT ROD PACKINGS

Like the one illustrated (Belmont 30), our many constructions have special features dependent upon services — asbestos, rubber and duck, plastic, metals, flax, jute, cotton, ramie.

BELMONT GASKETS

Woven asbestos boiler manhole and handhole; rubber and synthetic molded, extruded, die or lathe cut; compressed asbestos; vegetable fibre.



BELMONT LEATHER PACKINGS

Cup, flange, U and V shaped and washers in special tannages and treatments as service warrants.

"THERE'S A BELMONT PACKING FOR EVERY SERVICE"...

and the Belmont Distributor in your locality is ready to serve you. Write for his name and address.

THE BELMONT PACKING & RUBBER CO.

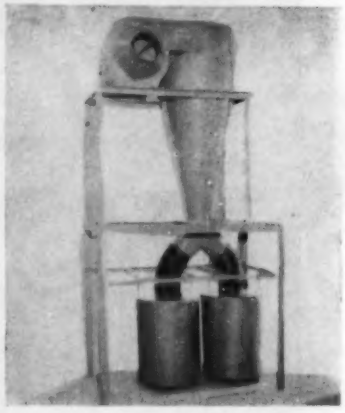
BUTLER AND SEPVIVA STREETS, PHILADELPHIA 37, PENNSYLVANIA

More EQUIPMENT NEWS

Begins on page 166

tion is necessary for installation and it can be installed anywhere that fuel, water and electricity are available. Claimed operating efficiency is 80% or better.

U.S. Radiator Corp, Cyclotherm Division, Oswego 5, New York



Dust collector

1016 • Unit has an air-handling capacity of 3600 cu ft of air per minute, with a static pressure of six inches of water. It is capable of collecting dust from practically any dust-creating machine or operation, especially where dust volume runs to rather high bulk.

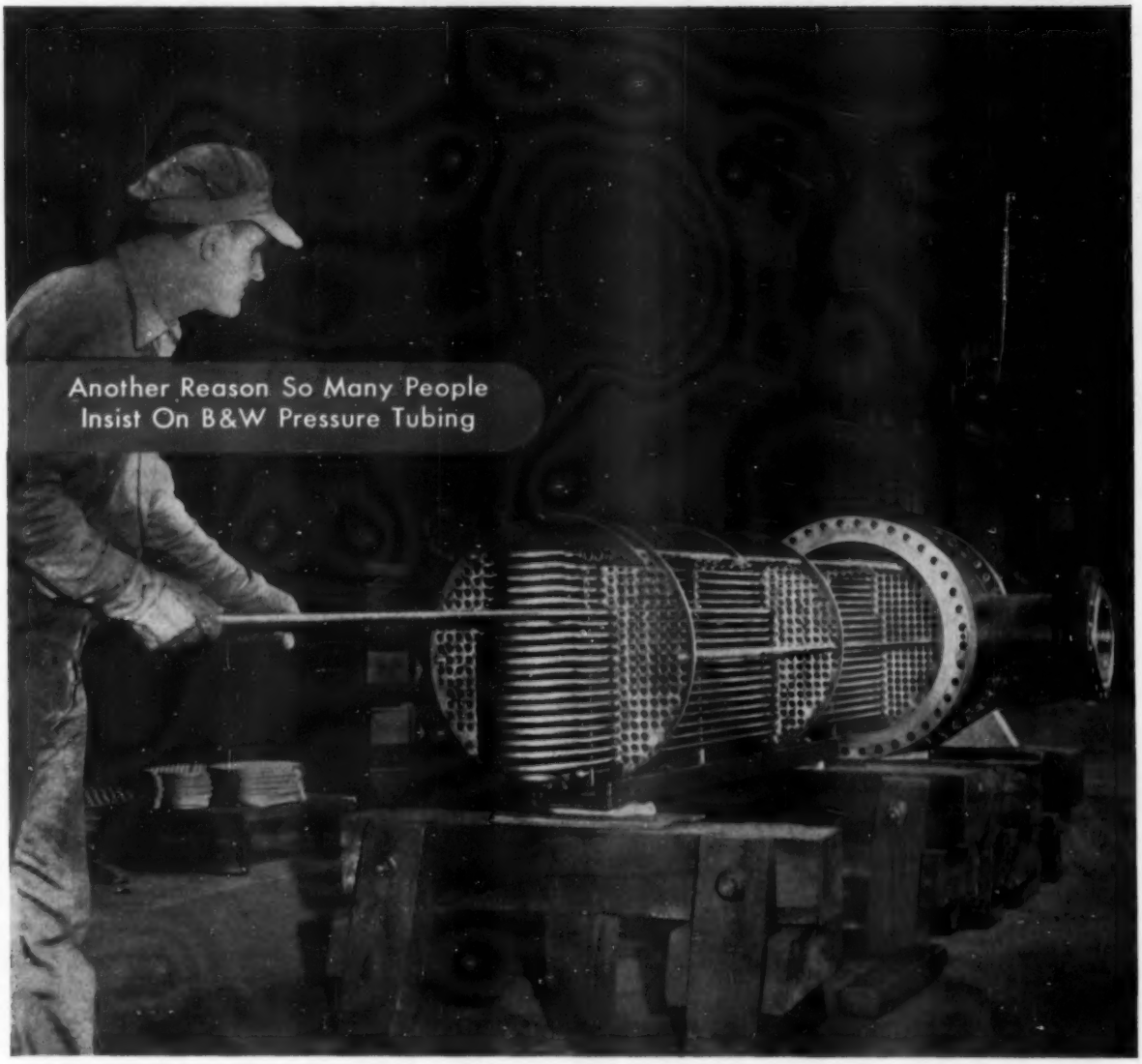
The collector eliminates emptying of a regular dust bin by shovel, with addition of two rubber-caster-roller dust cans that are connected to unit by an all metal diversion Y. Unit is available as a recirculating-air model or with attachments for outside exhaust where state codes or nature of the dust prohibits recirculation of air within the plant. Full details on request.

Aget Mfg Co, Adrian, Michigan

For more data on these items, use post cards p 175. Identify your request with item number.

Leak repair plugs

1017 • Units are used for making permanent or emergency repairs in gas lines, tanks and boilers. Made in many sizes, of heat-treated alloy steel, these plugs will take the strain of thread-cutting themselves into a hole to effectively seal the break. For permanent repair or to reinforce weak metal, plugs should be welded



TALK ABOUT TOLERANCES!!

In oil fields, refineries, chemical plants—wherever heat transfer is important—you'll find Griscom-Russell heat exchangers on the job. The Griscom-Russell Company uses B&W Pressure Tubing to help build its reputation for efficient equipment. There's no jamming or tube distortion when threading B&W tubing through tube sheets and baffle plates. This preoccupation with close tolerances—a workaday rule at both B&W and Griscom-Russell—assures closer control, greater efficiency in many heat transfer operations. In addition, B&W Pressure Tubing is famous for uniform ductility, tight joints, ease of rolling in, and low installation cost in any heat exchanger or condenser application.

For the complete story of how B&W Pressure Tubing can improve your operation, why not call in Mr. Tubes, your link to B&W. *Or write today for Bulletin TB-329P.*

B&W TUBULAR PRODUCTS DIVISION

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa. and Milwaukee, Wis.: Seamless Tubing, Welded Stainless Steel Tubing
Alliance, Ohio: Welded Carbon Steel Tubing
Milwaukee, Wis.: Seamless Welding Fittings

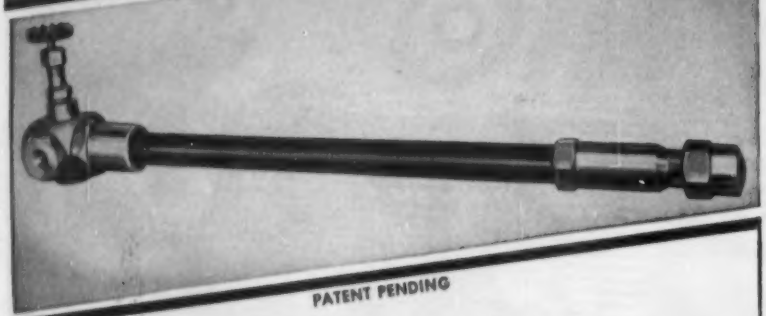
TA-5022(P)

NATIONAL AIROIL

OIL BURNERS

of the steam and mechanical types now combined into

DUAL STAGE BURNERS



PATENT PENDING

Now, at last, the inherent advantages of *both* systems of fuel oil atomization are *profitably* yours . . . within the one, new NATIONAL AIROIL Dual Stage Burner.

42 years of combustion equipment design and manufacture are in back of the Dual Stage Oil Burner . . . and, it has been thoroughly tested and proved in the field for firing: Petroleum Processing Heaters; Rotary Kilns; H.R.T., Scotch Marine and Water Tube Boilers; etc.

Available in three sizes, the NATIONAL AIROIL Dual Stage Burner fires all grades of fuel from No. 2 to No. 6, with a ready capacity of 80 to 300 g.p.h. Further, for a perfect flame pattern, we would recommend using with the Dual Stage Burner either the NATIONAL AIROIL Universal Register for forced draft or, the NATIONAL AIROIL Tandem Unit for natural or induced draft furnaces.

Get detailed description, illustration, and specifications in NATIONAL AIROIL Bulletin 25.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
STEAM ATOMIZING OIL BURNERS
SLUDGE BURNERS, Steam Atomizing
MOTOR-DRIVEN ROTARY OIL BURNERS
MECHANICAL PRESSURE ATOMIZING OIL BURNERS
DUAL STAGE, Combining Steam and Mechanical Atomization
LOW AIR PRESSURE OIL BURNERS
AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
GAS BURNERS
COMBINATION GAS & OIL BURNERS
FUEL OIL PUMPING and HEATING UNITS
FURNACE RELIEF DOORS
OBSERVATION PORTS
SPECIAL REFRACTORY SHAPES

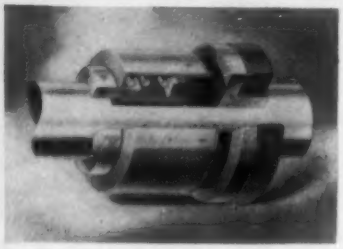
NATIONAL AIROIL BURNER CO., INC.

1250 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.
Southwestern Division: 2512 South Boulevard, Houston 6, Texas
INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

More EQUIPMENT NEWS

Begins on page 166

into place. A sample plug may be obtained on request to the manufacturer.
R H Baker & Co Inc, 2070 E Slauson Ave, Huntington Park, Calif.

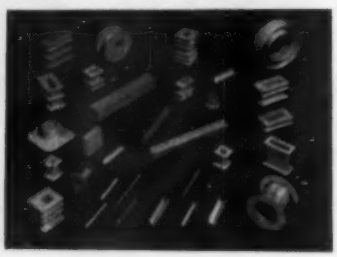


Mechanical seals

1018 • These seals are available for shafts from ⅜ to 3-in. diameters. Buna-N or neoprene bellows are furnished for operating temperatures to 212 F and pressures to 150 psi. Silicone bellows are provided for temperatures to 400 F where pressures do not exceed 50 psi.

Units are designed for use on rotary shafts of various types of equipment such as centrifugal pumps, gear boxes, speed reducers and agitators. Bulletin AD-150.
The Garlock Packing Co, Palmyra, New York

For more data on these items, use post cards p 175. Identify your request with item number.



Fiberglas-silicone parts

1019 • Complex-shaped thin-wall parts for Class H equipment are made of impregnated glass fabrics. They are laid up into shapes or deep drawn into special contours by slippage of the fibers or stretching of the fabric.

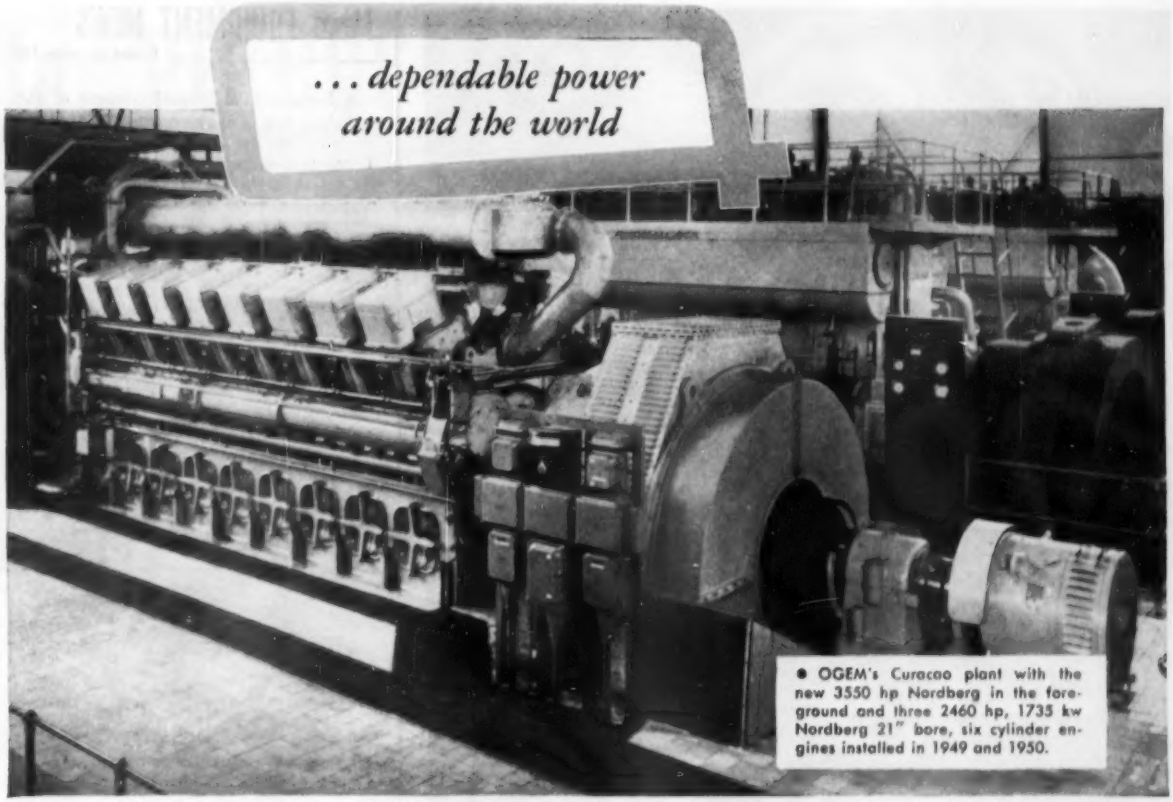
Bobbins of this type are said to have the advantage of good structural strength. There is actually no joint at the point where core and flanges meet as the Fiberglas fabric forming the core flares out into the flange and becomes part of it.
Silicone Insulation Inc, 567 3rd Ave, New York, N. Y.

Electrical contact burnisher

1020 • Pocket-size unit is fitted into a pen-type case. The burnishing element, a microfine surface, gives mild, controlled abrasive action. The abrasive, while it removes dust, grit and carbon build-up, removes a minimum of contact metal.

Manufacturer states that tests have shown frequency of contact maintenance

. . . dependable power around the world



• OGEM's Curacao plant with the new 3550 hp Nordberg in the foreground and three 2460 hp, 1735 kw Nordberg 21" bore, six cylinder engines installed in 1949 and 1950.

Netherlands West Indies Utility installs its 10th NORDBERG DIESEL

Here's evidence again of the reliability of Nordberg Diesels as N. V. Overzeese Gas En Electricitiet Mattschappij of Curacao, Netherlands West Indies places their *tenth* Nordberg engine in operation . . . a 16 cylinder V-Type *Supairthermal*® Diesel engine rated 3550 hp, 2500 kw at 500 rpm.

Installed at Curacao, the new engine gives this plant a total of 10,930 Nordberg horsepower. Four Nordberg *Supairthermal* engines are also providing 5640 hp at this progressive utility company's Aruba Island plant, and two 2670 hp V-type engines were recently placed in service at the Paramaribo station. *A total of 21,910 Nordberg horsepower!*

When additional power was needed, users like N. V. Overzeese Gas En Electricitiet Mattschappij, *naturally chose Nordberg again.* They have had proof of Nordberg's reliability and low operating and maintenance cost. *It's what they expect of Nordberg Engines!*

Next time you have a power problem, consult Nordberg. Write for further information, outlining your power requirements.

NORDBERG MFG. CO., Milwaukee, Wisconsin

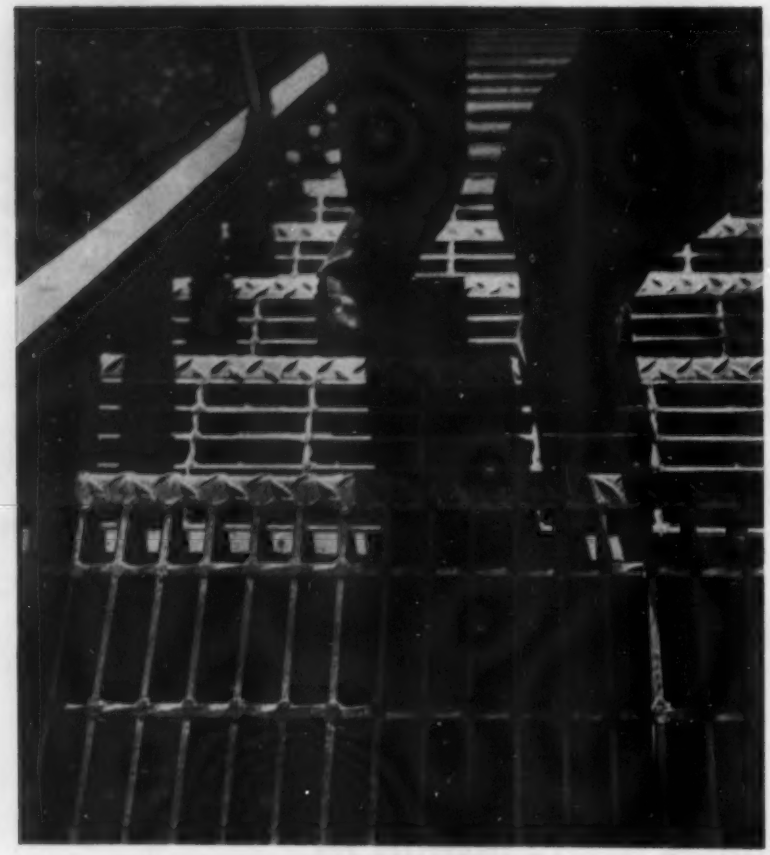
NORDBERG

DIESEL • DUAFUEL® AND SPARK IGNITION GAS ENGINES

BUILDERS OF AMERICA'S LARGEST HEAVY DUTY ENGINE LINE . . . 10 to over 12,000 HORSEPOWER

P955

© 1955, Nordberg Mfg. Co.



... make every step a safe step

BLAW-KNOX ELECTROFORGED®
STEEL GRATING and STAIR TREADS

On stair treads, walkways, catwalks, platforms and floors—both indoors and outdoors—you can provide safe walking conditions. For Blaw-Knox Electroforged Steel Grating brings you these exclusive features:

1. rigid one-piece construction—easy to install
2. non-slip twisted crossbar—for safe footing
3. three types of bearing bars
   - square bars—for smoothest walking surface
   - knurled bars (Furro-Grip)—for extra safety plus relatively smooth walking surface
   - serrated bars—for maximum safety under extremely hazardous skid conditions
4. no sharp corners to clog—self-cleaning
5. all surfaces accessible—easy to paint
6. maximum open area—for light and ventilation

Write for your copy of new Bulletin No. 2486
—or send dimensional sketch for quotation.

BLAW-KNOX

BLAW-KNOX COMPANY
BLAW-KNOX EQUIPMENT DIVISION
Pittsburgh 38, Pennsylvania

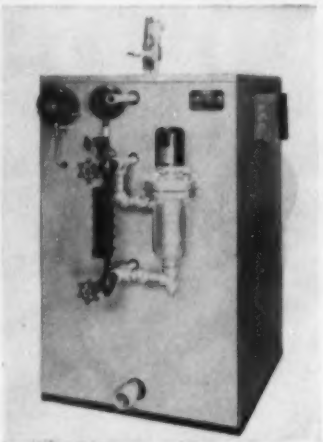
GRATING APPLICATIONS: floors • platforms • walkways • catwalks • stair treads • fan guards • shelving • and many other uses, both outdoors and indoors, for versatile steel grating

More EQUIPMENT NEWS

Begins on page 166

can be greatly decreased because of the polishing action of this burnisher. It leaves no oil film, grit, dirt or contact filings. Contacts become smooth, clean and shiny thus preventing new carbon-like buildups that require cleaning.

The Adre Company, Box 38, Hales Corners, Wisconsin



Packaged steam-generators

1021 • Electrically-operated units carry UL approval in sizes from 1½ to 15 Bhp. They are used wherever precise control of high-pressure steam temperature is desired or in places where fuel-fired boilers create explosion, fire or fume hazard. They may also be used as supplementary steam sources for areas remotely located from central boilers.

Unit efficiency is reported to be 98½%; power factor 100%. They may be operated on 220, 440 or 550-v power supply. The new line is being made in sizes from 1½ to 60 Bhp; 15 to 500 psi.

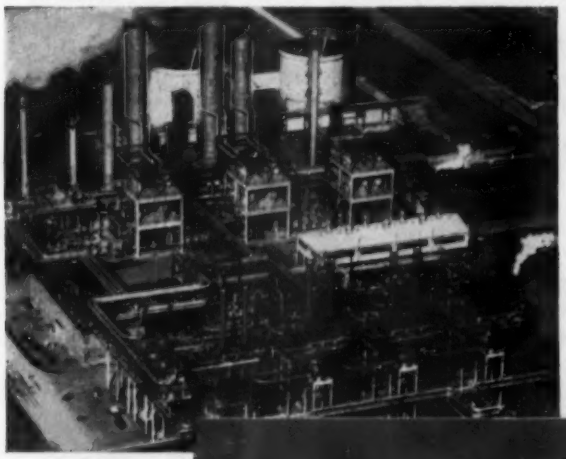
Pantex Manufacturing Corp, 440 Roosevelt Ave, Pawtucket, R. I.

For more data on these items, use post cards p 175. Identify your request with item number.

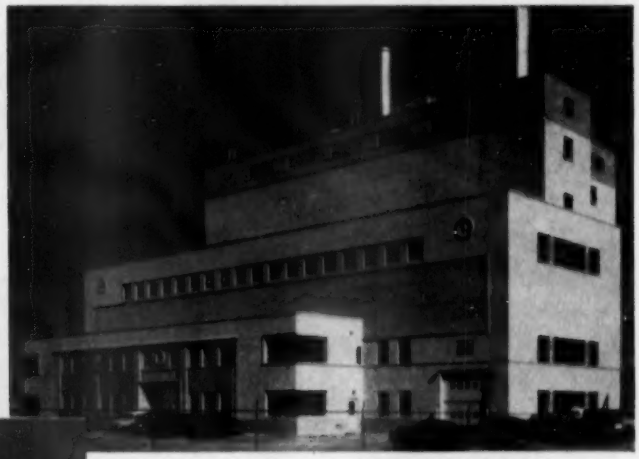
Heavy-duty masonry saws

1022 • Machines are equipped with a 2-hp continuous-duty motor to deliver special shapes and sizes in cutting every type of masonry and refractory material. Available in 14 and 18-in. blade capacities these saws

for PETROCHEMICALS or POWER



Sun Oil Company petrochemical plant, Marcus Hook Pennsylvania



Power plant, Colorado Springs Department of Public Utilities

KEY-KAST
Welding Fittings

Can Add Higher Strength at Lower Cost to Your Alloy Piping System

Whether your product is petrochemicals . . . power . . . or anything else requiring an alloy piping system, an investment in Key-Kast fittings can add higher strength and longer life to that system—and at a real economy, too. Here's why:

- Greater wall thickness throughout—for increased structural strength
- Extra thickness in critical areas—for greater allowance against erosion
- Lower unit cost
- Materials meet A.S.M.E., A.S.T.M. and A.S.A. Codes
- Rigid testing and inspection assure adherence to high standards of quality.

Key-Kast fittings are available in every shape, size, schedule—in low and intermediate alloys and various stainless steels

key company

Since 1916 . . . manufacturers and developers of products for high temperatures and pressures

DISTRICT OFFICES: NEW YORK • CLEVELAND
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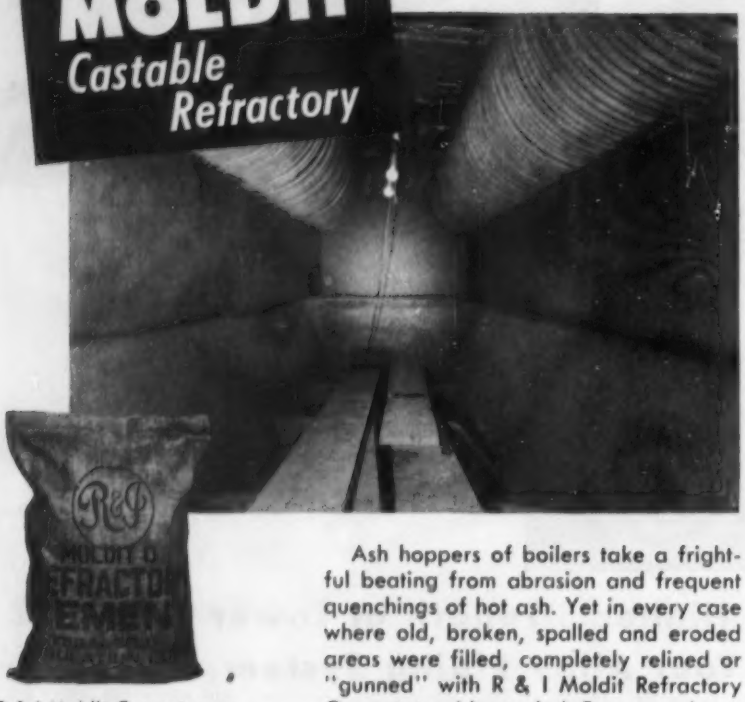
Not a Single Repair in 12 Years on ASH HOPPERS lined with MOLDIT Castable Refractory



R & I Moldit Cements are the most successful hydraulic-setting refractory materials, easy to pour, cast or gun as monolithic linings, facings and shapes of any size.

They are compounded to best meet specific thermal and mechanical conditions from 2000° to 3000° F.

Ash hoppers of boilers take a frightful beating from abrasion and frequent quenchings of hot ash. Yet in every case where old, broken, spalled and eroded areas were filled, completely relined or "gunned" with R & I Moldit Refractory Cement, troubles ended. For example:

- Moldit linings installed in the ash hoppers of two 800,000-lb. pulverized coal boilers 12 years ago are still going strong, without a single repair—and the original cost was only a few cents per pound for Moldit, plus very little labor.
- Another power plant saved $30,000 plus considerable downtime when they repaired several ash hoppers with Moldit-D refractory linings. That was 10 years ago —and the lining is still in good condition.

These success stories are typical of Moldit's service. It will pay you to investigate why you should use Moldit-D in your ash hoppers.

Send for catalog on Moldit and—while you're at it—get the story on Super #3000, the truly "wonder" refractory bonding mortar.

REFRACTORY & INSULATION CORP.

R&I

REFRACTORY BONDING AND CASTABLE CEMENTS
INSULATING BLOCK, BLANKETS AND CEMENTS

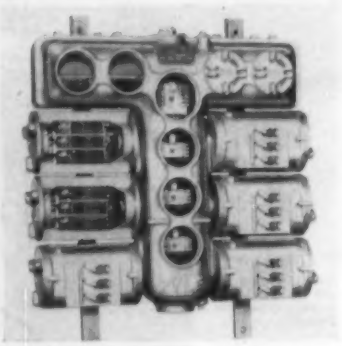
132 WALL STREET • NEW YORK 5, N. Y.

More EQUIPMENT NEWS

Begins on page 166

may be used for wet-and-dry cutting or dry cutting only. They may be easily converted to concrete or track saws. For trenching and patching in concrete or asphalt paving, the unit is mounted on a special cart. For cutting Transite sheets and other bulky material the cart is placed on a track. Full details available on request.

Clipper Mfg Co, 2800 Warwick, Suite 678, Kansas City 8, Mo.



Explosion-proof panelboard

1023 • Outstanding feature, according to manufacturer, is the triple-sectioned grooved joint that meshes cover, end plate and body to form a continuous metal-to-metal explosion-proof seal. Approximately three turns of the end plate releases the cover, which lifts off allowing complete visibility of, and quick access to the branch circuit breakers and all factory-made connections. All inspection and maintenance can be done from the front and two or more panelboards may be installed side-by-side on close centers with no interference. Units are available in 2, 4, 6 and 8-gang types. Request details from manufacturer.

Pyle-National Co, 1334 N Kostner Avenue, Chicago 51, Illinois

For more data on these items, use post cards p 175. Identify your request with item number.

Spindle-roll drive couplings

1024 • Crown-tooth gear-type couplings are designed for use in ferrous and non-ferrous blooming, strip, rod, sheet and structural rolling mills. Feature of this type drive, according to manufacturer, is patented tooth form. Its fully crowned flank is designed to carry a full load, concentrating it toward the center of the tooth to eliminate contact at tooth end. This permits higher shock loading and higher torque-carrying capacity. Tips of the teeth are also crowned and chamfered to eliminate tip loading and to permit accurate piloting of the sleeve teeth in relation to hub teeth. The unit is capable of accommodating up to ±9 degrees angular misalignment.

Amerigear-Zurn, Inc, 1801 Pittsburgh Ave, Erie, Pa.

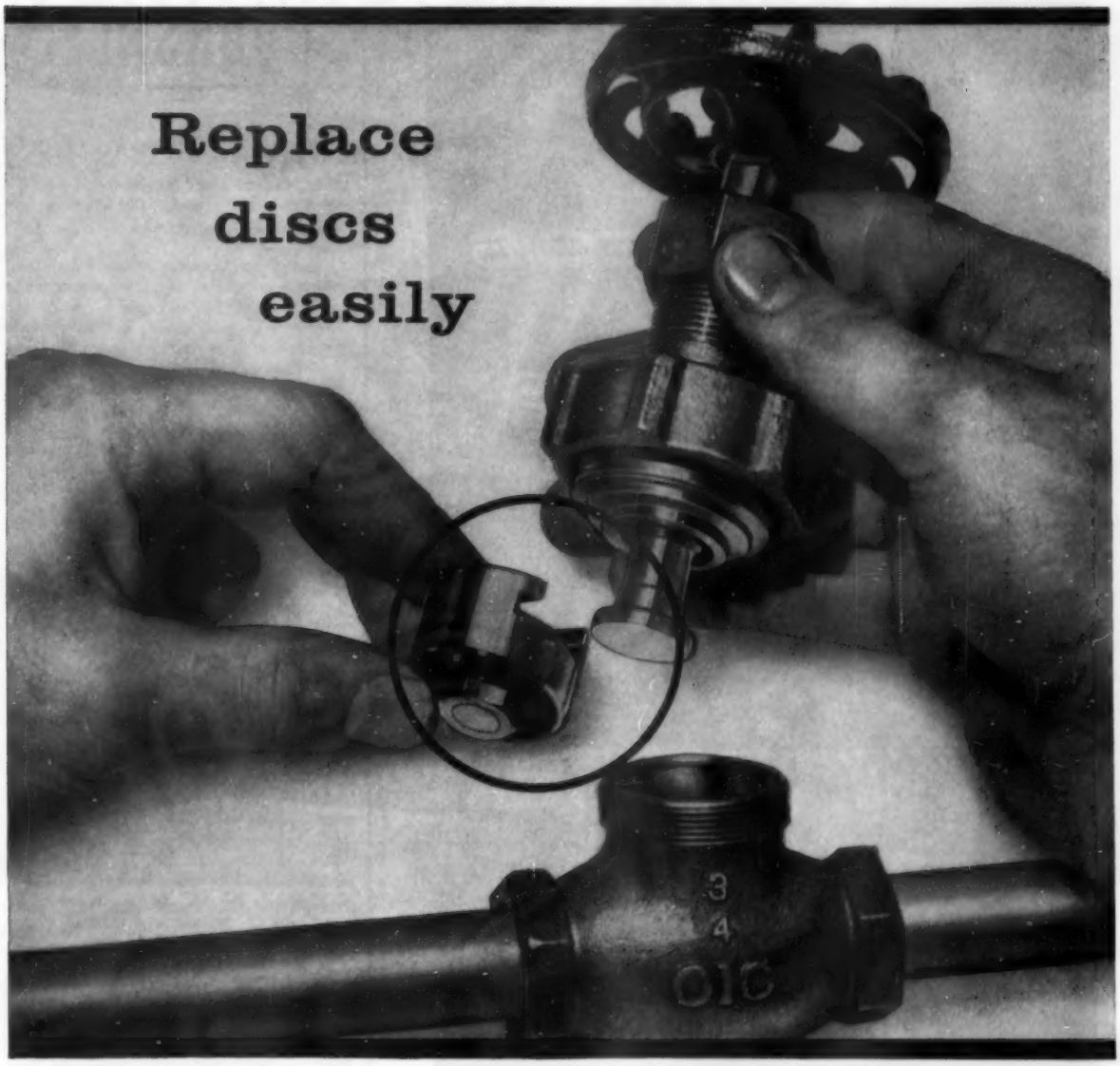


Fig. No. 520, 200 lbs. WSP, @400°F. 400 lbs. cold WOG, non-shock

It takes two minutes or less! Simply break the union joint and slip a replacement disc holder onto the button-head of the stem. Or, replace the disc only.

Additional features of this OIC line greatly reduce the need for other maintenance. For example: (1) The modern union body-bonnet joint assures a safe, tight, leakproof seal which is not affected by frequent dismantlings. (2) The special OIC *alloy-40* stem material eliminates galling and seizing. (3) Molded, graphite-asbestos, plastic packing is used which seals without hardening or cracking in service.

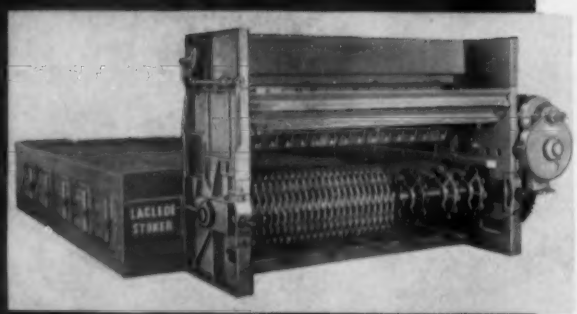
Reduce your valve problems by installing this OIC line wherever you need bronze globe and angle valves with composition discs. Call your OIC Distributor for more facts, or write for Form No. 1001 which describes the entire OIC 500 line with composition discs, as well as spherical and plug-type discs in globes, angles and checks.

OIC
FOUNDED 1883

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

VALVES | **FORGED & CAST STEEL, BRONZE & IRON, LUBRICATED PLUG VALVES**

OUR BUSINESS IS STOKERS



All our experience and talent have been used to build better stokers.

FOUNDED IN 1904

LACLEDE
STOKER COMPANY
4440 HUNT AVE. • ST. LOUIS 10, MO.

BOOKSHELF

Connecting and Testing Direct-Current Machines. *(Third Edition). By F A Annett, Contributing Editor,* POWER *and A C Roe, Manufacturing Engineer. 6 x 9, 328 pp, 218 illust, cloth, $5.00. McGraw-Hill Book Co, Inc, 330 W 42nd St, New York 36, N. Y.*

Modern methods for connecting dc motors and generators and for locating faults in their armatures and field windings are described in this book. The material is designed to give electrical engineers and maintenance and repair workers practical help for rebuilding dc machines for higher ratings and longer operating life, and for testing for winding faults. Procedures for changing a series type into a shunt machine or vice versa, converting a dc generator into a motor or vice versa, figuring new windings for old dc machines, and many other operations are presented.

Location of winding faults is treated in detail. Also featured in the Third Edition is new material on testing armature windings and field coils, high-temperature insulations, insulation testing devices and techniques of high-frequency, low-energy, surge-voltage testing.

Everything and the Kitchen Sink. *By Philip Lesly. 160 pp, 7¾ x 10¾, illust, $4.00. Farrar, Straus & Cudahy, Inc, 101 5th Ave, New York, N. Y.*

The "everything" of this intriguing title refers to the thousands of inventions and technical developments of the past hundred years—the things that have made American civilization as we know it. The "kitchen sink" stands for the many contributions of the Crane Co, in commemoration of whose centennial this book is published.

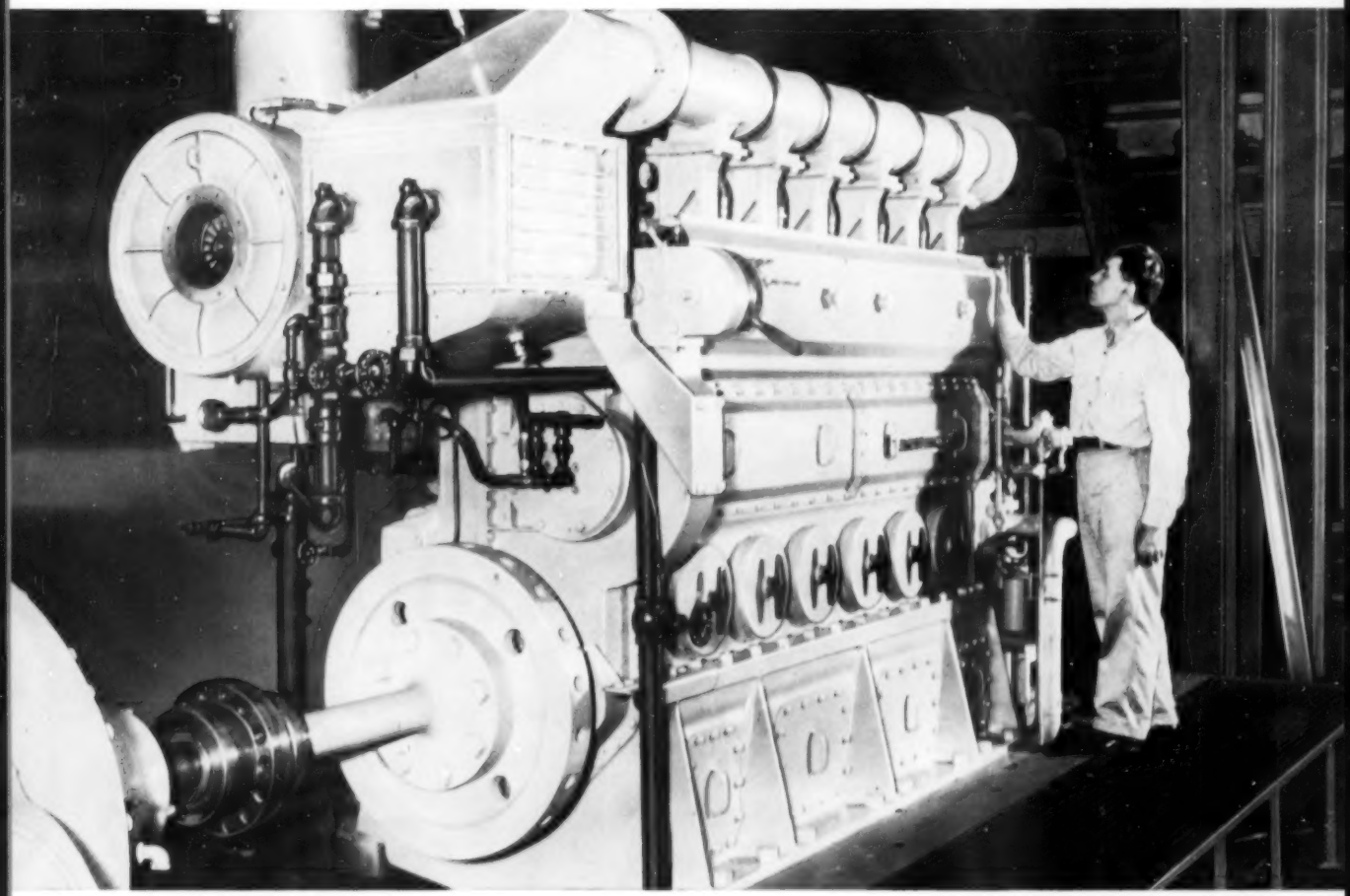
In the hundred years since Richard Teller Crane poured the first brass molding in his new Chicago foundry, the face of America has been changed completely. This is the story of that dramatic change, told in warm words and significant pictures. And it is the story of the men who brought about that change—the men of industry, like Richard Crane, who turned the ideas of inventors into familiar reality. It holds fascination for anyone interested in how we got to where we are today, but particularly for engineers; the progress it records is primarily technical.

Brazing Manual. *Prepared by Committee on Brazing and Soldering, American Welding Society. 6 x 9, cloth, 193 pp; illust, charts, tables. $4.75. Reinhold Publishing Corp, 430 Park Ave, New York 22, N. Y.*

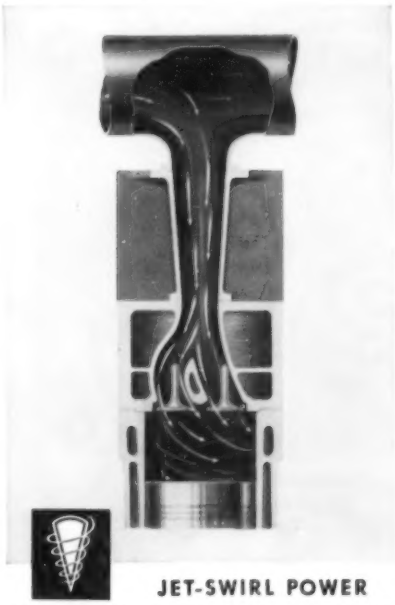
This manual is a collection of the principles, equipment and procedures involved in all eight brazing processes. Complete technical information is given on torch, twin-carbon arc, furnace, induction, resistance, dip, block and flow brazing. All metals of industrial importance are described in terms of brazing techniques including equipment, preclaiming, surface preparation, postbraze cleaning and inspection.

(Continued on page 196)

WORTHINGTON ANNOUNCES



NEW W9 ENGINE. Available as straight Diesel, dual-fuel, or spark-ignition gas engine, with or without turbocharging.



JET-SWIRL POWER

FOR HIGH OUTPUT EFFICIENCY. Aerodynamically perfect passage gives minimum flow resistance. Directional baffle imparts swirling motion to air entering cylinder for perfect combustion fuel-air mixture.

new, heavy-duty 400-1400-hp W9 engine

for continuous service

The new Worthington W9 engine is designed and built for minimum possible weight consistent with heavy-duty service.

It's a true, continuous heavy-duty engine, yet compact enough for portable, semi-portable, standby or emergency and marine power service. A welded steel base makes it easy to adapt to existing foundations, trailer or railroad-car frames, or drilling rig structures.

What's more, the W9 features the newly developed Worthington Jet-Swirl air intake (*left*) that produces controlled turbulence in the cylinders for best mixture of fuel and air for fuel economy. Streamlined passages and directional baffles between double intake valves give the incoming air a swirling motion that ensures fast, complete fuel-air mixture.

Available as a straight oil Diesel, dual-fuel Diesel or spark-ignition gas engine, in four basic sizes, with or without turbocharging. Nominal speed: 900 - 1000 rpm.

TURN PAGE FOR MORE FACTS

Here's what the NEW WORTHINGTON W9 ENGINE gives you-

Check these features

1 ***Jet-swirl air intake passages*** give maximum air turbulence for complete fuel-air mixture and best fuel economy.

2 ***Massive crankshaft***

3 ***Hydraulic valve lifters*** eliminate clearance adjustments, give quiet, efficient operation.

4 ***Cast-in-cylinder water jacket*** eliminates sealing rings between crankcase and water jacket — eliminates possibility of lube oil contamination.

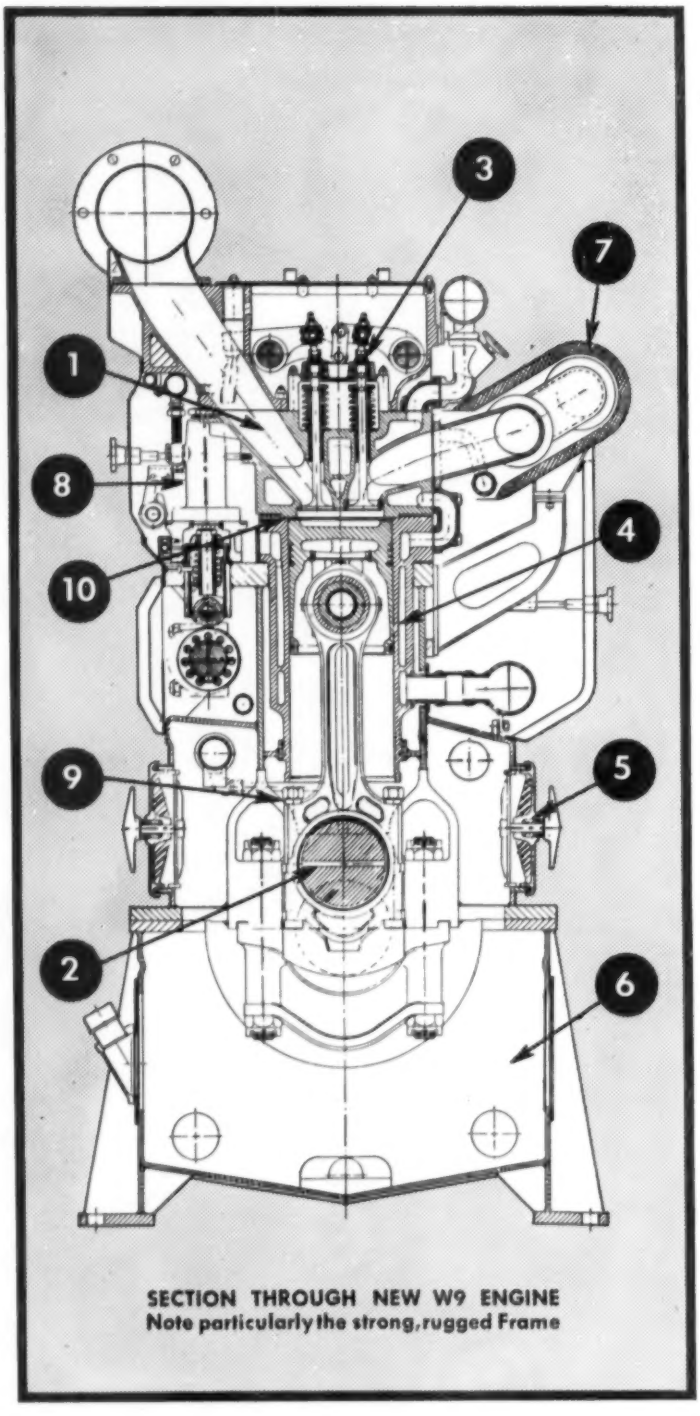
5 ***Large, easily removed inspection doors*** make maintenance easy and do double duty as spring-loaded pressure relief covers.

6 ***Welded steel base*** can be mounted on flat surface or made to suit any existing structure — provides maximum strength with minimum weight.

7 ***Dry insulated exhaust manifold*** reduces cooling water requirement — provides extra energy to turbochargers.

Of course, the new W9 engines have the same features found on larger Worthington engines: separate fuel pumps (8) for each cylinder, four-bolt connecting rods (9) and head design (10) that eliminates need for gaskets.

Get the whole story on the new Worthington W9 engine. Write Worthington Corporation, Section E.5.8, Harrison, New Jersey.

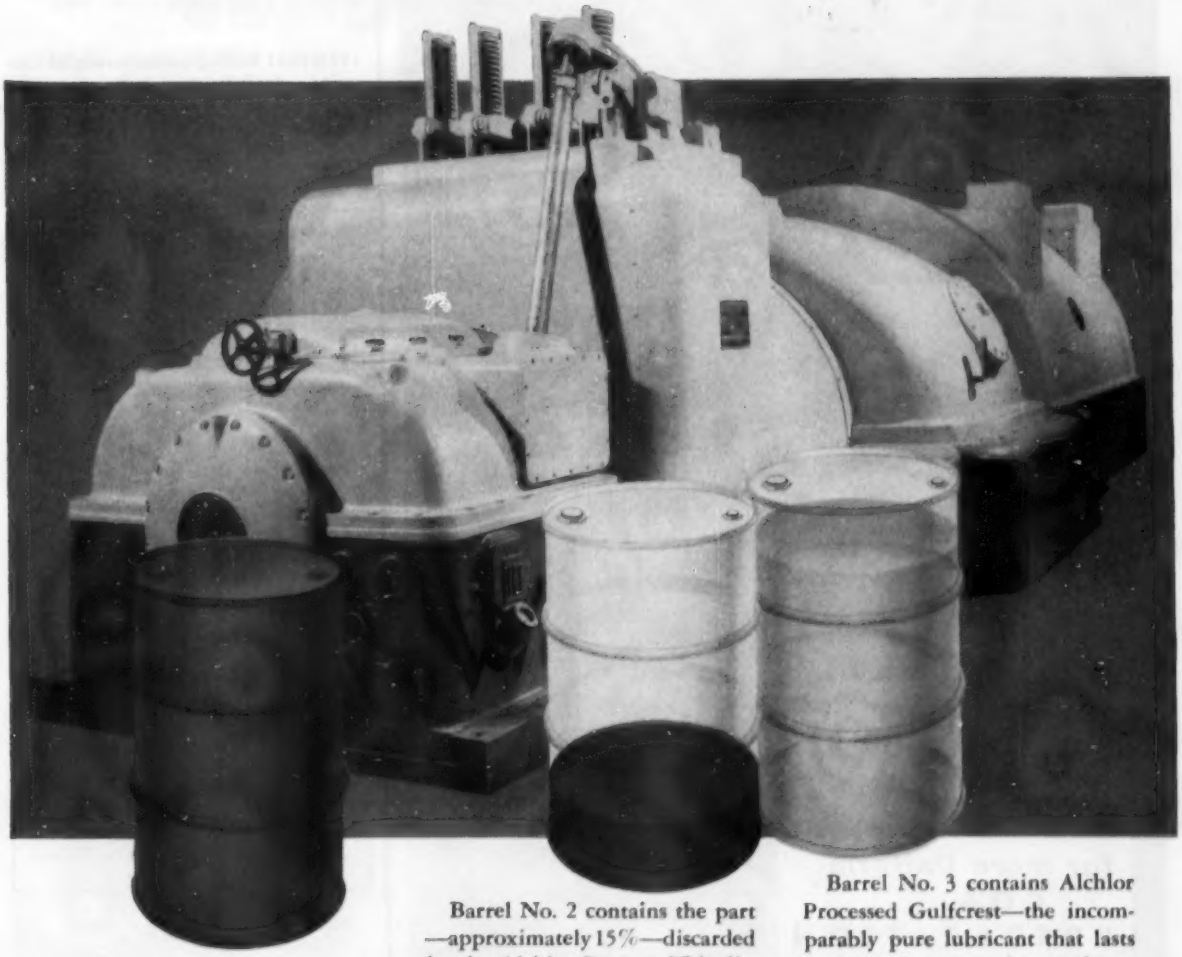


SECTION THROUGH NEW W9 ENGINE
Note particularly the strong, rugged Frame

WORTHINGTON

Economical, Continuous Power — *Diesel, Dual-Fuel and Spark-Ignition Engines, from 150 to 5,000 bhp*

GULFCREST *is the only turbine oil that is super refined for superior performance by the ALCHLOR PROCESS*



Barrel No. 1 contains a highly refined oil that will become Gulfcrest. It has gone through the usual steps used in refining other turbine oils—but has not yet been Alchlor Processed.

Barrel No. 2 contains the part —approximately 15%—discarded by the Alchlor Process. This discarded portion contains unstable hydrocarbons which, if allowed to remain in a turbine oil, are likely to oxidize, increase neutralization number, form sludge, emulsifiers, and harmful acids.

Barrel No. 3 contains Alchlor Processed Gulfcrest—the incomparably pure lubricant that lasts longer, gives superior performance and helps keep your turbine systems clean indefinitely. To make Gulfcrest even finer, special inhibitors are added to give it still greater stability and protect against corrosion and foaming.

Call your nearest Gulf office today and have a Gulf Sales Engineer recommend the proper grade of Gulfcrest Oil to meet the specific requirements of your turbines.

GULF

GULF OIL CORPORATION • GULF REFINING COMPANY • 1822 Gulf Building, Pittsburgh 30, Pa.

American
ROLLING RING
COAL CRUSHERS
COAL IS SPLIT NOT CRUSHED

for More Uniform
COAL
PREPARATION
Proved by Hundreds of Millions of Tons of Reduced Coal.
Coal Crushers up to 800 TPH
Sample Crushers up to 15 TPH
COAL PREPARATION PROBLEM?
Write for Recommendations and Literature.
American PULVERIZER COMPANY
1349 MACKLIND AVE. • ST. LOUIS 10, MO.

More BOOKSHELF

Begins on page 192

An appendix charts the properties of brazeable metals and alloys.

Brazing fluxes and atmospheres are standardized into types according to their composition and uses. The manual includes sections on production, design, testing, quality control, safety and health protection. It details the causes of brazing defects and tells how to correct them.

1950-1951 Bibliographic Survey of Corrosion. *Available from National Association of Corrosion Engineers, 1061 M & M Bldg, Houston 2, Texas. 430 pp, 8½ x 11, hard cloth, $12.50 to non-members NACE, $10.00 to members NACE.*

Summaries of 4454 corrosion and corrosion prevention articles, books and brochures published in 1950-1951 are compiled in this volume. The NACE Abstract Filing Index is used to classify the material topically. Literature is put into eight main groups: general, testing, characteristic corrosion phenomena, corrosive environments, preventive measures, materials of construction, equipment and industries. Each main group is subdivided. Topical cross-references are appended to each section.

The subject index lists many metals and alloys by trade name and indexes them as to specific properties and to behavior in specific media.

This is the fourth in a series of NACE bibliographies on corrosion literature. The preceding three volumes, covering 1945 through 1949, contained 7960 abstracts.

CORRECTION

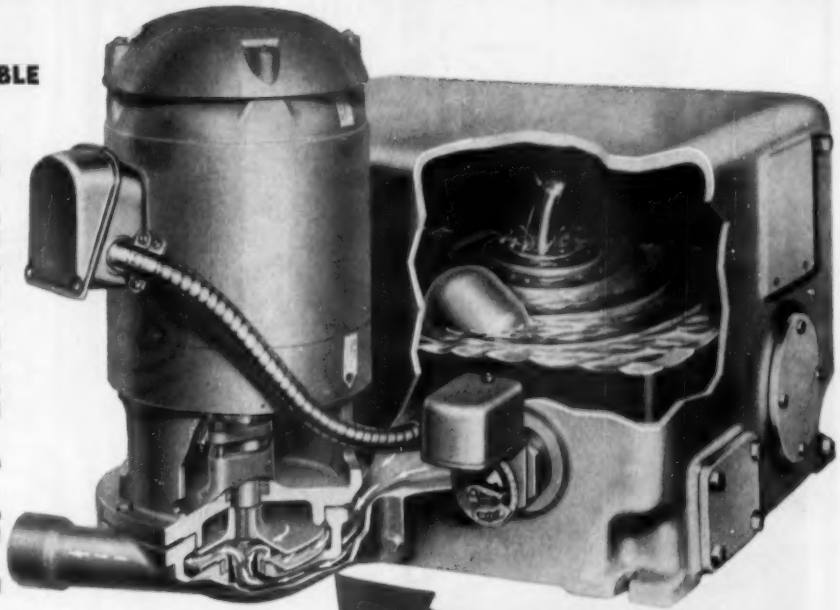
Correct title and author of the second book reviewed on p 242, June POWER is Falk's Graphical Solutions to 100,000 Practical Problems. Prepared and edited by Karl H Falk. 419 pp, 6 x 8½, illust, cloth, $6.00. Columbia Graphs, Columbia, Conn.

"Little scale in here . . . water must be off again."

HOFFMAN NEW AND IMPROVED CLOSE-COUPLED CONDENSATION PUMPS

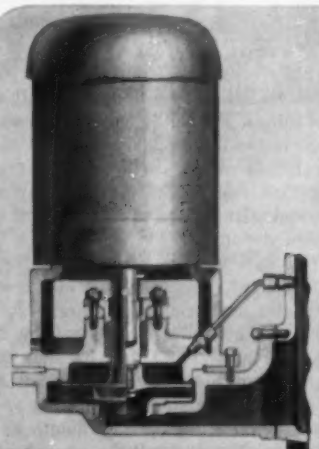
DESIGN FEATURES THAT ASSURE YOU THE MOST MODERN PUMP AVAILABLE

1. Bronze fitted throughout.
2. Enclosed, precision balanced bronze impeller that handles hot water effectively.
3. Stainless steel shaft extension accurately turned and ground with impeller securely locked.
4. Handy drain plug for draining impeller casing.
5. Ball bearing motor made and guaranteed by leading manufacturer 40° C. continuous duty, with ample overload capacity.
6. Heavy rust resisting cast iron receiver.
7. Heavy duty float control with seamless copper float and stainless steel rod.
8. No piping between pump and receiver.
9. Float switch is adjustable for various water levels in receiver.
10. Rigid motor support for quiet operation.



Type "HCS" Single Unit Hoffman Condensation Pump

WATER FLOWS DIRECTLY FROM CAST IRON RECEIVER INTO CENTRIFUGAL PUMP



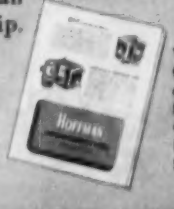
ENCLOSED, PRECISION BALANCED BRONZE IMPELLER ON STAINLESS STEEL SHAFT. PUMP UNIT IS BOLTED DIRECTLY TO WATER TANK.

SINGLE AND DUPLEX UNITS—RATINGS THROUGH 150,000 SQ. FT. E. D. R.

A Compact Pump Combining Dependable Performance with Low Power Cost

The full benefits of rapid condensate removal at low operating cost are yours with this highly efficient, dependable Type "HC" unit. These new, improved pumps are designed to operate at a wide range of pressures without over-loading the motor and are especially adapted for operation at the extremely high temperatures encountered in condensation pump service. All cast iron and bronze construction, they are so designed that parts subject to wear can be easily renewed. All together, these HC Pumps are a typical Hoffman product of sound design and excellent workmanship.

For small systems: "Watchman No. WC-8-20" Pump for low pressure heating systems. Ratings: up to 8000 sq. ft. E.D.R. Pump Capacity: 12 gallons per min. Pressure: 20 lbs. per sq. in. at pump discharge. ⅓ HP standard NEMA motor.



Write today for your copy of this new Hoffman Condensation Pump Catalog.

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Makers of Valves, Traps, Hot Water Heating Systems, Vacuum and Condensation Pumps — Sold by Leading Wholesalers of Heating and Plumbing Equipment

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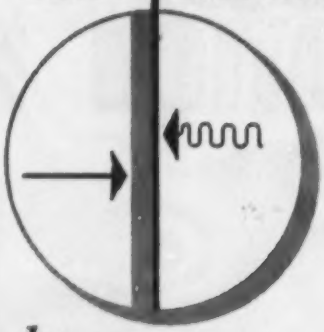
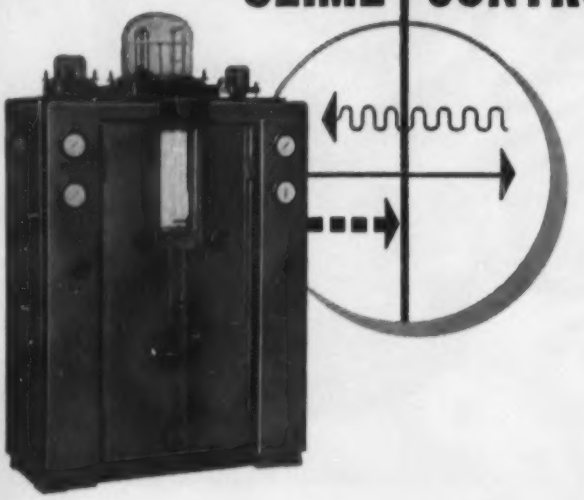


Be sure you have

SLIME | CONTROL



Whether you heat or cool water for make-up, process or any other use, you will need Wallace & Tiernan Chlorination to help combat slime problems introduced by water-borne bacteria or air-borne bacteria.

With slime control equipment designed for any need, built for lasting and dependable service, highly accurate and backed by over 40 years of successful application experience, Wallace & Tiernan Chlorination can help you increase the efficiency of your plant and cut operating costs. For further information write our Industrial Division.

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CD-39

MARMADUKE

Continued from page 154

around the brewery. That evening I reported to headquarters. I told my boss if they followed my advice, regardless of how waterlogged it sounded, that plant would run as expected before long.

"First I explained their steel stack had certain disadvantages over a brick stack. For one thing, a steel stack isn't as hot in cool weather. Then because she isn't as hot, you don't have the chimney effect. But I assured him that because of a scientific theory, known as thermalferrum, the steel stack could be made to do its work.

"'How'? asked my boss, thinking they'd have to sink a lot of money into my idea.

"'All you have to do is paint the stack's base,' I said, watching his face closely.

"'Paint the base?' he echoed, almost plugging his windpipe with his cigar.

"'That's right, paint the base,' I assured him. 'But this doesn't call for just any kind of paint or any kind of paint job. First of all, it's a special scientific stuff that must be put on in designs, depending on your draft problem that I've got to calculate. We need both a Nubian black and luster white paint, used in the right designs and combinations. The ratio of black and white areas must be just right for your problem. And you have to paint the base only about ten feet up from the foundation, plus or minus a half inch.

"'It sure sounds crazy to me,' is all he could say, chewing his rope yarn. The boss was a good business man and didn't claim to know any science, but I could see this was one time he found it hard to swallow my advice 100%.

"'When I dope out my solution tonight,' I continued before he could ask questions, 'I'll have that paint doing two things. First, it'll induce air movement inside the stack due to molecular absorption of the corrugated light refractions. Second, it'll attract stray bithermal triangulated rays because of its design dynamics.'

"By now he was groggy, so I kept hitting hard. 'To make this idea work without a new brick stack, you've gotta see that the painter carries out my design. Maybe you and your partners can cash in on this job by roping off an area around the stack and letting your visitors watch while the painting is going on. You can tell the newspapers all about it. That might get you some good publicity to help put your brewery over. Maybe you owners can explain my theory to the crowds as they watch. That should give them something to tell their friends. At the same time the

This New B&W Hollow Forgings Bulletin ...gives comprehensive data on an unusual subject

Fully detailed, with charts, photographs, tables and text, this just-published bulletin provides a broad coverage of what, very often, is both an engineering and procurement problem.

Its contents include:

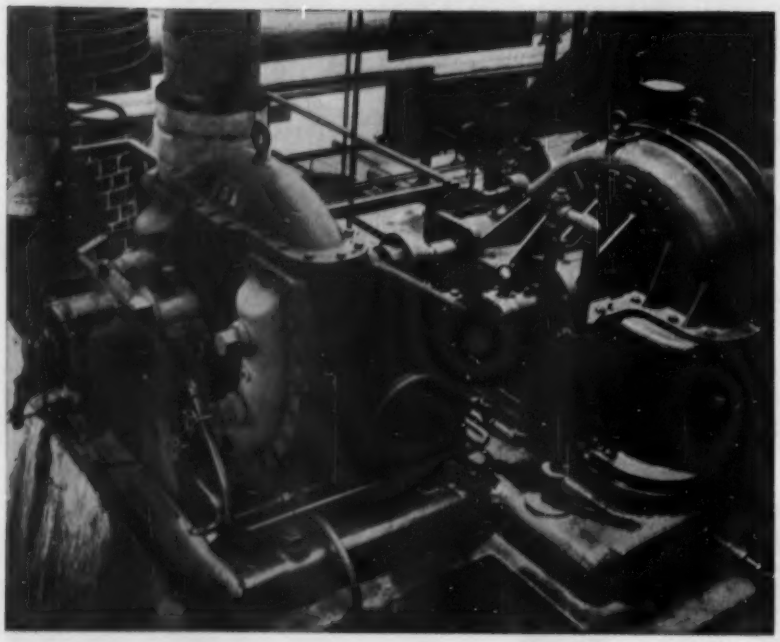
- Specifications
- Materials Reference Table
- The Hollow-Forging Manufacturing Process in Pictures
- Photomicrographs of Castings and Forgings
- Sizes — Carbon, Intermediate Croloys and Austenitic Stainless
- Analyses of Standard Hollow-Forgings Alloys

For ready and complete Hollow Forgings reference, send for Bulletin S-16B to The Babcock & Wilcox Company, Process Equipment Department, Barberton, Ohio.

BABCOCK & WILCOX
BOILER DIVISION

S-444

Murray Turbines



One of 4 Murray type turbo-gear units installed in a southwest rubber plant still giving trouble free service after 12 years in an unprotected outdoor location. This unit drives an Induced Draft Fan requiring 425 HP at 683 RPM. The turbine speed is 3500 RPM.

• Murray turbo-gear units for mechanical drive are right at home in difficult outdoor installations. Fans, pumps, compressors, and many special types of slow speed machines are among the long list of installations powered by Murray turbo-gear units.

Murray gears are of the Herringbone or Double Helical type and all are pressure lubricated at the point of tooth contact.

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

MARMADUKE

Continued from page 198

visitors can be served beer and that'll help your business.'

"And that's exactly what happened. That night local papers blasted the stack story sky high. Next day visitors overran the place like schools of hungry fish. They rubbernecked while the painter carefully laid out the designs I had worked out.

"Those large crowds got the owners real interested in the project. Like most people who are suddenly put into the limelight, the partners and the showoff brewmaster turned out to be ham actors at heart. While the crowds slopped up free beer around that stack's base, those guys did a lot of talking, shaking hands and drinking with them. The painter turned out to be another ham. You'd think he was Michelangelo the way he squinted his eyes and carefully painted on that new 'scientific paint' I got for him.

"After a few days, letters appeared in the papers from readers who said my stack theory was so much 'humbug.' By then the owners didn't care because they were cashing in on the publicity. The painter was told to take his time and make the job last for two weeks. He gloried in performing before the crowd and he liked drinking. So that part was no problem. Besides, everyone wanted to try the beer that—they joked—was made with 'scientific paint.' Future beer sales started booming and the partners had some nice fat orders on their books to make them happy.

"By the end of two weeks, just about the time the top brass started getting weary and the crowds began slacking off, the plant was running at top efficiency.

"I met with the partners that last Saturday evening in the brewery's office. We worked six full days of ten hours a day in 1902. They called in the chief engineer. He told them the plant was perfect, that it was the sweetest running job he had ever operated.

" 'What I can't understand,' said the treasurer, who had looked on my recommendations as a lot of monkeyshines from the very beginning, 'is how that paint job had anything to do with getting the bugs out of this plant. I'll accept the Chief's word that his plant is OK, but I think Mr Surfaceblow here owes us an explanation before we give him this $1,000.'

" 'Sure,' I answered, reaching for the check and anchoring it safely in my billfold. 'I'll be glad to explain. Soon as you big shots and the visitors stayed the hell out of the plant for a few weeks, the operators had a chance to run their job. So they straightened things out quickly

A. P. GREEN

Plastic and Castable Monolithic Linings Give Higher Operating Efficiency . . . Lower Maintenance Costs in Watertube Boilers

Monolithic refractory linings, properly installed, give better combustion efficiency and longer service life than any other type lining.

During operation, the sections of a furnace are subjected to different conditions. Each A. P. Green product has been developed to meet the service requirements of the zone for which it is specified. A. P. Green plastic and castable furnace linings installed under the supervision of trained personnel give you the full benefit of monolithic construction, plus the advantages of "zone-rated" materials.

SUPER HYBOND is a special super duty plastic that develops high strength throughout its entire thickness . . . regardless of furnace operating temperature. It is ideal for use in spreader stoker arches and piers, behind waterwall tubes, and as a seal around tubes where they pass through the wall.

SUPER-PLASTIC . . . a super duty plastic designed for use where operating conditions are unusually severe. Gives excellent service in complete monolithic linings, side walls in furnace area, flat suspended arches and spreader stoker arches. Patching and repairing firebrick or plastic linings with SUPER-PLASTIC results in longer, more efficient service.

PLASTIC QUIK-PAK . . . a high duty plastic refractory which combines refractoriness, low shrinkage and hot load bearing strength. It is used in constructing monolithic side walls and in patching those portions of watertube boiler linings which do not require super duty plastic.

KAST-SET is a high quality refractory castable which develops a strong hydraulic bond without application of heat. Recommended for convection sections of watertube boilers, baffles, waterwall backing, linings for stacks, breechings, flues, and ducts.

KAST-O-LITE is a lightweight, insulating castable refractory for temperatures up to 2500° F. Used for monolithic linings in convection sections of boilers. Reduces heat loss. Insures closer temperature distribution and control.

For properly engineered monolithic linings call your A. P. Green distributor —he's listed in the yellow pages of your telephone directory.

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Safety Head Division, Dept. 2Q10
7500 East 12th Street
Kansas City 26, Missouri

MARMADUKE

Continued from page 200

since people weren't getting in their way or breathing down their necks every few minutes. My first look-see told me the plant was OK to start with. All the engineers needed was to be left alone so they could do a day's work and get the feel of their plant. I told you I'd get the bugs out of your plant, and that's exactly what I did. I got *you* bugs the hell out of there.—*SME*

Marmy's Mailbox

NOT AN UNDERWEAR TEST

Marmy has a delightful personality, but his underwear test of heat insulation would embarrass him if he met a smart aleck from Astoria. Our well-insulated steam lines are given a nice appearance by a covering of very thin, shiny corrugated aluminum. It looks nice and retards heat loss but you wouldn't sit on it in your underwear plus two pairs of pants.

V C JOHNSTON *Flushing, N. Y.*

"TECHNICAL FICTION"

I've had so much fun reading my new book, *The Marmaduke Story*. I suggest you call his stories "technical fiction," after science fiction. On telling engineer friends about these stories, I was surprised to learn that many have been reading Marmy in POWER. Some have also ordered his book. So you see your character is famous even in a little-big industrial city, in this corner of the world.

E VERALDI
Winterthur, Switzerland

ENTERTAINS, EDUCATES

Just finished reading *The Marmaduke Story* and find it highly entertaining and educational. Please accept my sincere congratulations on the fine job he is doing in presenting solutions to problems of power engineers in such an entertaining fashion. I shall heartily recommend this book to engineers I contact.

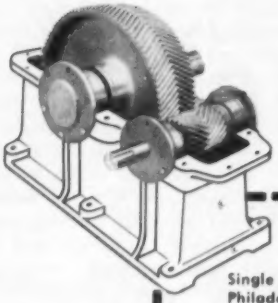
W C STRICKLER, *National President, NAPE*
Washington, D. C.

BE MORE CAREFUL, PLEASE

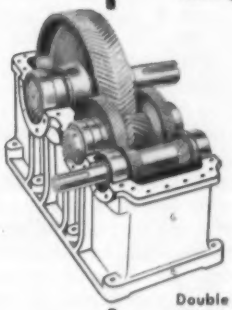
You really should be more careful when quoting Marmy. I'm sure that deep-water sailor would never be guilty of saying "the Admiral's ears started turning red as two starboard running lights." If you're not more accurate in your quotations, you may lose a star admirer.

D M SHACKELFORD
New York, N. Y.

REDUCER PROBLEM?...consult



Single reduction
Philadelphia
Herringbone Reducer



Double reduction
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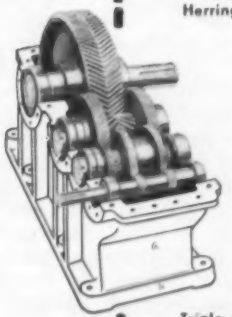

Triple reduction
Philadelphia
Herringbone Reducer

If you have a problem involving high horsepower speed reduction with heavy shock loads, Philadelphia Herringbone Reducers are the answer. These quality-built units are available in Single, Double and Triple Reduction types, offering a wide selection of capacities and reduction ratios. The continuous tooth type herringbone gears assure evenly distributed pressure over each tooth from the top to the working depth line, — which means exceptionally long life, minimum vibration, quiet operation and maximum transmission of power... Thousands of Philadelphia Herringbone Reducers are in daily use, in most every line of industry. Be convinced, send for Catalog H-49.

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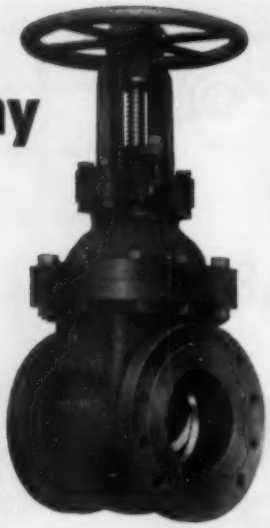
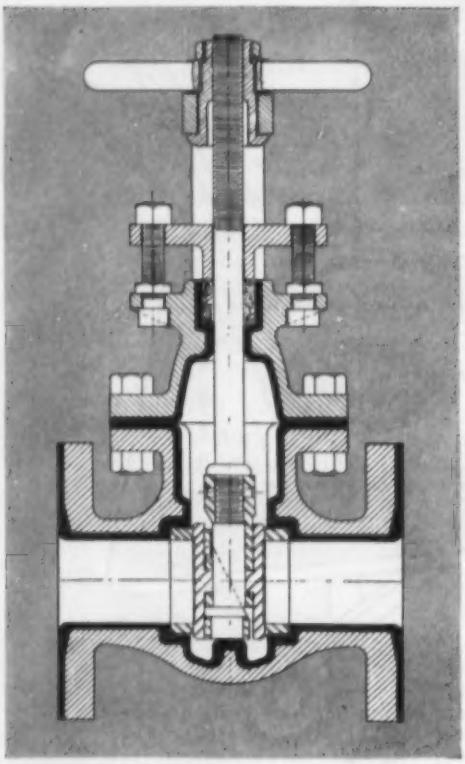
Virginia Gear & Machine Corp., Lynchburg, Va.
Industrial Gears & Speed Reducers • LimiTorque Valve Controls
Established 1892

FOR double economy in corrosive service





● *Darling rubber-lined iron body gate valves, with special alloy working parts, offer trouble-free corrosive service and big savings. Available in rising stem, cylinder or motor operated, or quick-opening types.*

HERE'S a Darling gate valve that can save you plenty of dollars in corrosive services up to 180° F. This is an iron body valve with a hard rubber lining permanently bonded to all exposed interior surfaces, and suitable for working pressures up to 150 pounds.

Equally important, this valve features Darling's *fully revolving double disc parallel seat principle* which is unexcelled for trouble-free performance, tight closure, low maintenance and long life.

Weigh these facts and potential savings, then write for complete data on these job-proved rubber-lined iron body valves.

DARLING VALVE & MANUFACTURING CO.
Williamsport 8, Pa.
Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.

NUCLEAR ENERGY

Continued from page 110

has been run with liquid sodium. This type pump is proposed for sodium-graphite thermal-reactor plants.

Another type shaft seal uses a labyrinth with an inert-gas feed to control leakage. This seal is especially adaptable to sodium because of its favorable vapor pressure-temperature relation. The sump-tank volume above the free liquid surface can be held at ½- to 1-in. water gage below atmospheric pressure. The number of sodium-vapor molecules in the total-mixture volume (mostly inert gas) will be small even up to 1000 F. And in a radioactive Na-coolant system, only a small number of sodium-vapor molecules will be Na-24, the radioactive isotope.

With an inert-gas feed at about 2-in. wg pressure at the top of the labyrinth seal of Fig. 5, the sodium-vapor molecules Na-23 and Na-24 will escape through the seal in accordance with the law of diffusion governing molecule migration. The labyrinth seal raises several problems that must be studied: (1) length of seal (2) shaft diameter (3) labyrinth and shaft-material combination (4) radial clearance between labyrinth peaks and shaft (5) cost of gas leakage, especially with helium or argon (6) alignment during start-up and operation (7) pump and motor critical and resonance speeds—probably desirable to use stiff-shaft unit running below first critical (8) reliability and expected life of unit, because of difficulty of replacing seal device remotely.

It may be necessary to use a back-up contact-face-type seal to reduce the inert-gas leakage. This arrangement is now undergoing test in handling liquid sodium. Considerable work has been done on similar seal ideas. To date a satisfactory seal of this type has not been developed for radioactive liquids.

Materials to handle radioactive coolants have been covered in No. 13, Sept 1944, POWER, p. 99. Materials satisfactory for shafts and bearings include: (1) surface-hardened stainless steel to stellite or Colmonoy (2) stellite to stellite (different grades).

Dc and ac pumps. Fig. 6 shows a direct-current electromagnetic pump for liquid metals. This pump needs a high-amperage very-low-voltage power supply. One of the best types of power supply is a unipolar-type generator with a NaK hydro-type brush collector.

Fig. 7 shows the Einstein-Szilard (reverse-flow) ac induction-type electromagnetic pump. While using the same principles as the linear flat-bed pump it has several basic advantages over that type: (1) no transverse cur-

STEEL FORGINGS by MESTA

for HIGH PRESSURE and HIGH TEMPERATURE PIPING

custom made to your mechanical and metallurgical specifications

PIPE

TEES

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VALVE BODIES

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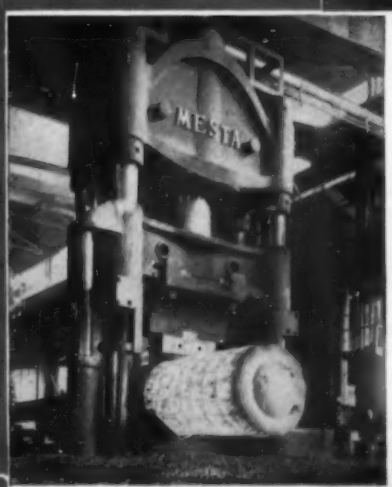

● Forging High Pressure—High Temperature Pipe on a MESTA 6000 Ton Hydraulic Press in one of the MESTA Forging Shops.

Chrome Molybdenum Alloy Steel Pipe forged, machined, rigidly inspected and tested to comply with customer and code specifications. MESTA Forged Piping provides confident service in High Pressure and High Temperature Piping Systems.

MESTA FACILITIES *for Piping Forgings*

Electric Steel and Open Hearth Furnaces
Forging Presses • Heavy Duty Machine Tools
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ROLLING MILLS • ROLLS • FORGINGS • HEAVY DUTY TOOLS

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

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Garlock CHEVRON* Packing • At every pressure, from the lowest to the highest, this popular packing provides a positive, low friction seal. Ideally suited for use on hydraulic cylinders (both single and double acting), hydraulic rams, plungers of pumps and other reciprocating rods.

Garlock CHEVRON Packing

Garlock Leather Packings • Cups, "U" packings, "V" packings, washers, gaskets, discs and flange or hat packings, are available for all types of hydraulic service. Specify Garlock BITAN*, a chrome-and-oak-tanned leather, or THIOTAN* a synthetic rubber impregnated leather.

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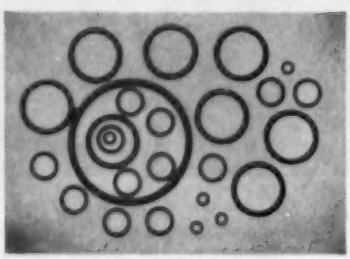
Garlock O-Rings • Made to Garlock's rigid quality standards, these O-Rings are manufactured with precise tolerances, a flash-free finish, and utmost uniformity. 70 durometer rubber O-Rings in all popular sizes are available from any of Garlock's branch warehouses.



Garlock O-Rings

Call your Garlock representative or write for information on hydraulic packings, designating for which type, or types, you desire literature.

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GARLOCK

PACKINGS, GASKETS, OIL SEALS,
MECHANICAL SEALS, RUBBER EXPANSION JOINTS

NUCLEAR ENERGY

Continued from page 204

rent-leakage loss (2) slightly higher over-all efficiency (3) greatly reduced inlet and outlet transition-joint design and fabrication problems (4) less severe thermal-expansion problem (5) greatly reduced structural problem resulting from evacuation of unit down to a few microns absolute pressure for mass-spectrometer leak testing (more about this later).

The biggest single item against these pumps to date is that only a few very-small-capacity pumps have been built and tested. On the other hand, 3000-gpm 80-psi flat-bed units have been built and tested. One minor problem is the gas and possibly vapor trapping and venting. This is only a design detail that has to be checked.

Other types of liquid-metal pumps include dual-flow electromagnetic and the em centrifugal.

Here's how the over-all efficiency and costs of these pumps compare:

Pump type	*Over-all effy, %*	*Relative cost*
Mechanical:		
Canned-rotor	65	3.0
Sump (frozen or gas shaft seal)	75	1.0
Electromagnetic	50	2.0

Both constant and variable-speed pumps of either type are used in coolant systems. Speed control can be of infinite-step type or stepped type over a limited range. With a thermal reactor, various speed-control methods are used since hydrogenous fluids may be applied. For mechanical-type pumps these include:

A. Infinite-step control
   1. Wound-rotor motor and liquid or drum rheostat
   2. Eddy-current coupling
   3. Fluid coupling
   4. Magnetic coupling

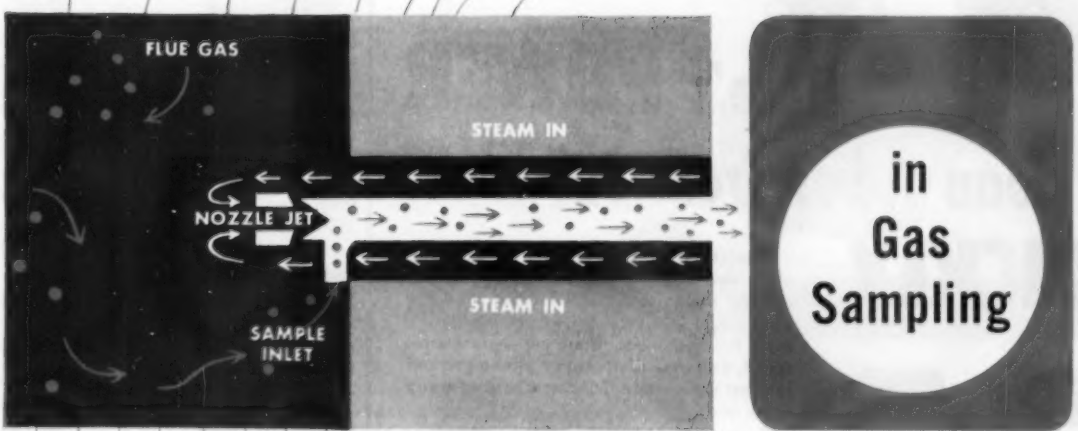
B. Stepped-speed control
   1. Induction motor with stepped transformer control for 100, 80, 60% speed steps.

Any method is used with fast reactors as long as non-neutron-moderating fluids can be used in the speed-control device. The only exception to this would be the wound-rotor motor and liquid rheostat —the latter could be remotely located with respect to the motor and pump.

For ac em-type pumps, both voltage and frequency, separately or together, can be used to control speed over a wide range.

Choosing between variable-flow and constant-flow pumps for coolant systems depends on: (1) number of coolant systems (2) predicted operating characteristics of plant including con-

NEW DIMENSIONS



in Gas Sampling

NEW SAMPLING SYSTEM OPERATES ON STEAM!

The new Hays Gaspirator* System is designed especially for difficult gas sampling problems involving high dust loading and high temperatures. It now permits accurate O_2 measurement, previously impossible in many applications.

This gas sampling system uses steam to obtain a continuous, clean sample. Suction which is created by the jet nozzle draws the sample in, where it is mixed with the steam. The steam is then condensed. Condensate and entrained solids drop down, and the sample is forced through the analyzer under pressure.

Hays, in the field of gas analysis for more than fifty years, developed the Gaspirator for use with their Magno-Therm Analyzer.

This analyzer, which operates on the paramagnetic principle, has for years been accepted as the leader in the field of O_2 measurement. Hundreds of companies are using the Magno-Therm and Hays electronic recorders very successfully in boiler plants and on process furnaces as a combustion guide, in regeneration of catalysts in refineries and in many other process applications.

For further details write for Bulletin 55-829-56.

*Patents pending.

THE **hays** CORPORATION

MICHIGAN CITY 1, INDIANA

Here's POWER to clean tubes from 1/2" to 2" QUICKLY

Rotojet Junior Tube Cleaners are unusually powerful for their size and weight. They are fed easily through the tubes with the operating hose, and can be shifted quickly from tube to tube. Their convenient size, speed, and ease of operation offer a marked contrast with external cleaners costing many times more.

An air valve directly behind the Rotojet motor permits one-man operation. Very little headroom is required, and either vertical or horizontal tubes can be cleaned.

Simplicity of Rotojet design and precision construction assure long service, efficient use of power, and freedom from trouble. Economical brushes, cutters, and scrapers meet practically any requirement.

Send for Bulletin J-410.

Expanding scraper and replaceable element.

Expanding brush and replaceable element.

Sectional wire brush.

Air valve for one-man operation.

ROTOJET®

Junior TUBE CLEANERS

ELLIOTT COMPANY-ROTO DIVISION

153 SUSSEX AVE. • NEWARK 1, N. J.

NUCLEAR ENERGY

Continued from page 206

sideration of part-load and refueling coolant-system operating periods (3) type of fuel and refueling method (4) relative cost of pump types (5) parallel operation of pumps over plant life (6) over-all economics of constant versus variable-speed design. Each case must be considered on its own merits—no two plants are identical in design.

The next part will cover valves, heat exchangers and steam generators.

PUMP CHOICE

Continued from page 127

ity by the correction factor obtained above to find the stock capacity at the bep, or 1600 (0.87) = 1392 gpm.

3. Next, find the percent of stock capacity at the required rating (1000 gpm) to stock capacity found in step 2 (1392 gpm). Or, (1000/1392) (100) = 72%. Checking with Fig. 6, this capacity and efficiency is not near the bep. When this occurs and stock consistency is over 3.5%, subtract actual consistency from above ratio, or 72–5 = 67%. This gives a value which helps save time in solution.

4. Find the correction factor for 67% capacity by entering Fig. 4 at 67% and projecting upward to a consistency of 5%. At the left, read the correction factor as 0.91. Divide the stock head and capacity by this correction factor to determine the final water rating of the pump. This gives 1000/0.91 = 1100 gpm, and 75/0.91 = 82.4-ft total head. Locate this point in Fig. 6. It occurs at an impeller diameter of 14.75 in., point *C*, Fig. 6. To check the validity of this impeller diameter, find the water capacity at the bep. This value must approximately equal the capacity used in step 2. Fig. 6, shows a capacity of 1650 gpm at 82% efficiency. This compares favorably with the 1600 gpm used in step 2. If the capacities vary appreciably, repeat steps 2, 3 and 4, using another value in step 2.

5. To plot approximate head-capacity curves for this pump handling water and stock, tabulate the water head, efficiency and bhp from Fig. 6 at 40, 60, 80, 100 and 120% of rated capacity at the bep for the impeller diameter found in step 4, or 14.75 in.

6. Tabulate the correction factors, using the above percent capacities and Fig. 4. With these, compute the stock gpm and total head, as above. Horsepower input remains about the same.

Plot the computed values, Fig. 7. Pump efficiency is computed from: Efficiency = (gpm) (head,ft)/(3960) (bhp) (stock specific gravity). Note that the horsepower on stock is almost the same as on water.

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FIG. 3031 WE—Steel O.S. & Y. Globe Valve For 300 Pounds W.S.P.

FIG. 11303—1500-Pound Pressure Seal Steel Gate Valve.

FIG. 1331-A—1500-Pound Steel Integral Bonnet Offset Globe Valve.

FIG. 3059-G—300-Pound Steel Lubricated Plug Valve. Gear Operated.

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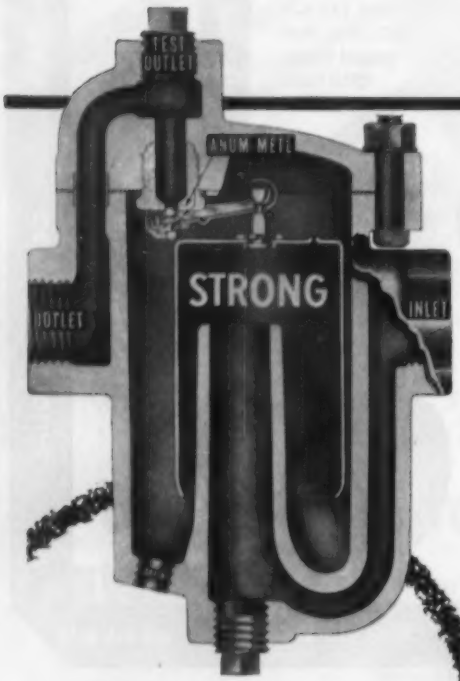

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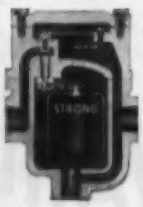

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BURNERS, STOKERS

Continued from page 107

less oxygen per unit of heat released than carbon or sulfur do. Carbon and sulfur are the other usual combustible elements in fuels.

Natural draft. In the simplest systems, a chimney or stack produces enough draft to withdraw the combustion gas from the boiler, and to pull the required air into the furnace through the burning equipment. A damper at the boiler exit regulates the quantity of gas pulled through the boiler. Individual registers or dampers distribute air equally to all burners or stoker sections, or cut off air from idle burners.

Theoretical draft produced by the chimney depends on the relative density of the cool ambient air and the column of light, hot gas inside the boiler and chimney. The higher the chimney and the greater the difference between average chimney and ambient temperatures, the greater the draft.

Draft is really the difference in weight, and hence pressure, of the two columns of gas, one cool and the other hot. It is generally measured in inches of water.

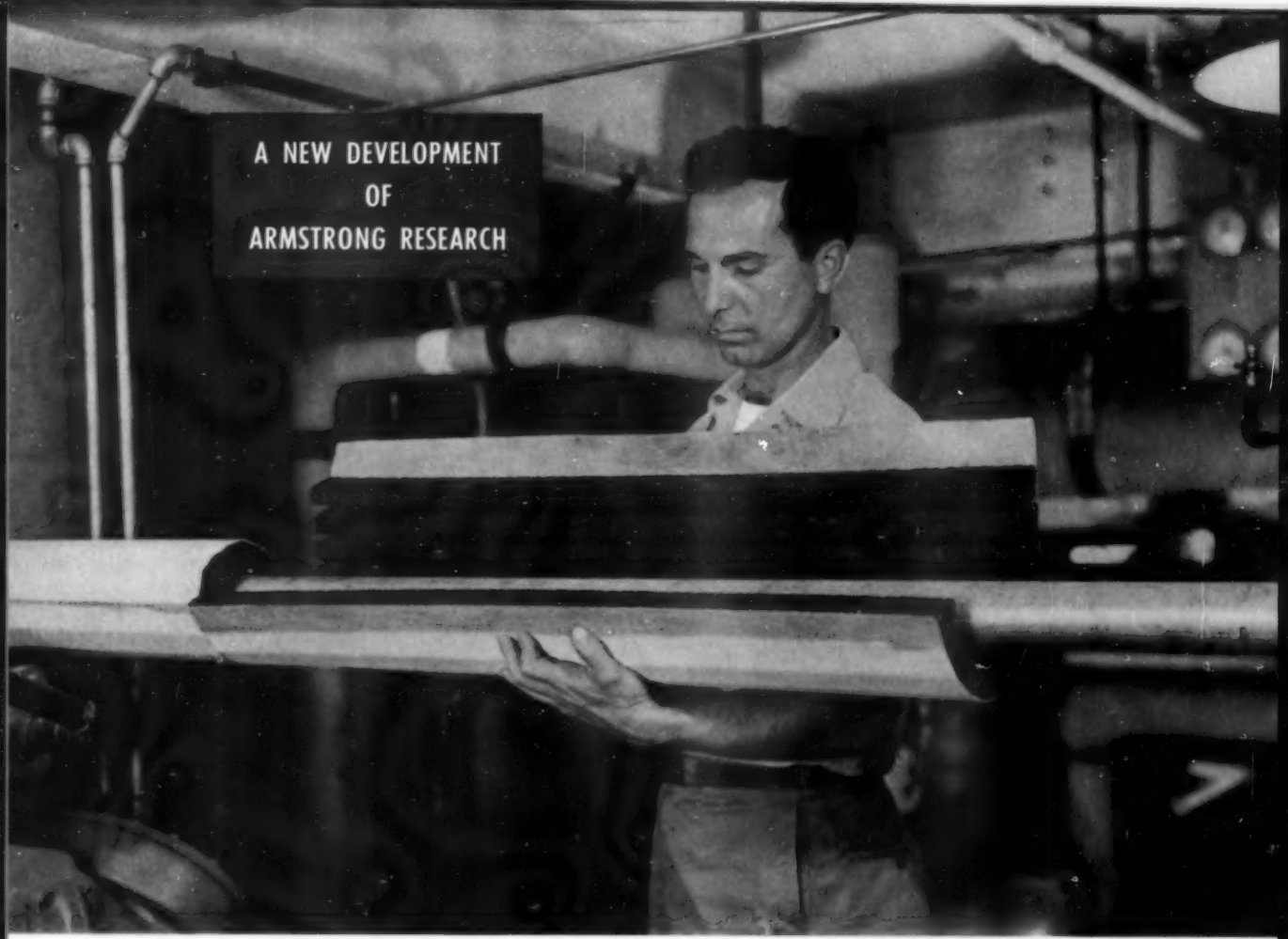
Effective draft available for boiler operation is not the same as theoretical draft. It is reduced by the amount of head lost in friction as gas passes through the boiler, breeching and chimney. Enlarging sectional areas of these elements and eliminating sharp turns and flow irregularities reduce friction. This also increases the amount of air flow you can get through a boiler, with a given chimney height.

As boiler output increases, temperature of the exit flue gas usually rises, producing more theoretical draft. But friction losses usually increase fast enough to overbalance this tendency. In hot weather the stack-temperature difference will probably decrease, thus reducing available draft.

When running a boiler on natural draft, the burner or stoker air-control dampers should be as wide open as is consistent with good burning action. This reduces the draft needed on furnace and boiler, and thus cuts air infiltration at points in the setting where air cannot be effectively used.

Forced draft. Where draft from a reasonably high chimney will not pull enough air through burners or through a thick fuel bed on a stoker, forced-draft fans provide additional pressure. You can adjust air to the fuel being burned by means of dampers at the fan discharge, or by varying the fan speed. The uptake damper is regulated to keep a slight suction (usually 0.2 to 0.3 in. of water) in the furnace.

If additional rating is required, you



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LT Cork Coverings are fabricated from precision-cut sections of Armstrong Corkboard bonded to a fire-resistant, asbestos and aluminum foil jacket. The aluminum foil acts as a built-in vapor barrier. The white jacket presents a trim appearance that usually requires no further finishing.

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The development of LT Cork Coverings is another example of how Armstrong continues to work to improve industrial insulation materials and methods. For descriptive booklets on the entire Armstrong line of industrial insulations and Complete Contract Service, call your nearest Armstrong office or write Armstrong Cork Company, 2010 Stratton St., Lancaster, Pa.

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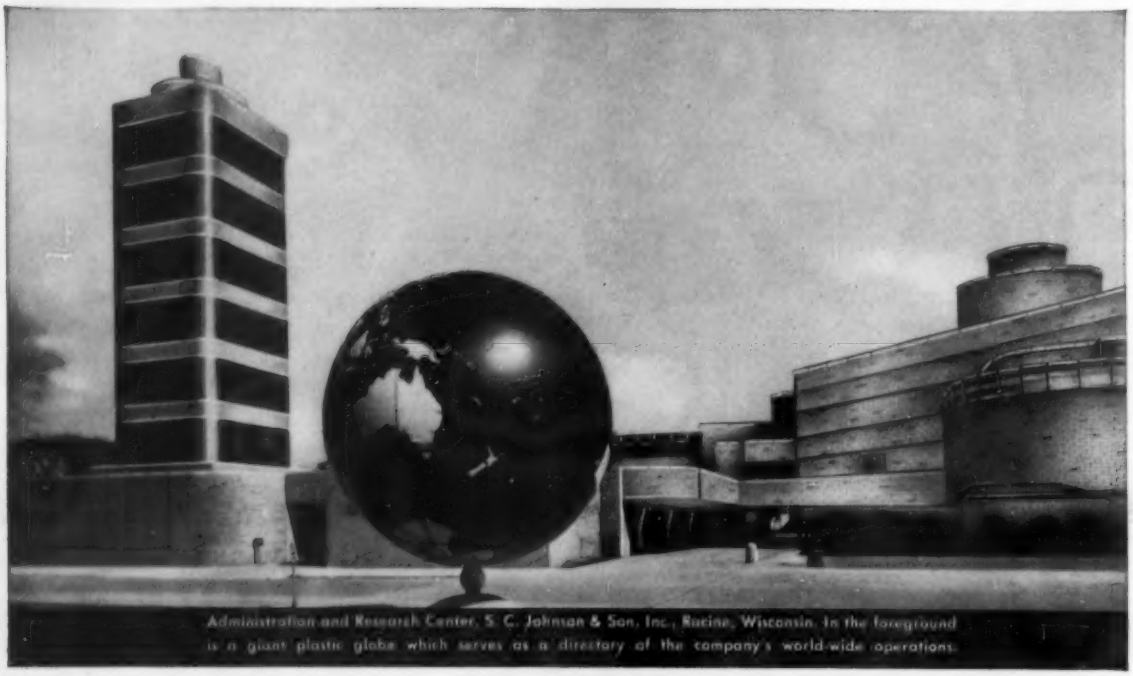
LT-Thirty Cork Covering prevents sweating under normal conditions at line temperatures of 30° F. or above. LT-Zero is suitable at temperatures down to 0° F.; LT-Minus Thirty at temperatures to −30° F.

MAKERS OF JOHNSON WAX PRODUCTS TELL ABOUT THEIR VIBRA-GRATE



Administration and Research Center, S. C. Johnson & Son, Inc., Racine, Wisconsin. In the foreground is a giant plastic globe which serves as a directory of the company's world-wide operations.

TWO YEARS AGO, S. C. Johnson & Son, Inc. was in the market for a stoker for their Racine plant. Impressed by the advantages of the Vibra-Grate (which AE had been licensed to build in U.S. and Canada) Johnson engaged a German consulting engineer to investigate a number of European installations. These included Vibra-Grates in service since 1947, and earlier models dating back to 1939. Johnson instructed American to proceed with the work immediately, subject to the engineer's report which, when received, confirmed Johnson's decision. Their comments after the unit had carried the plant load to May, 1955, will interest everyone seeking maximum stoker efficiency and economy.

"We put our Vibra-Grate Stoker in service in October 1954 and it has frequently carried loads of 45,000# steam per hour, its rated peak capacity, and has often operated at loads of 10,000 to 15,000# per hour.

"We have found no objectionable fly ash at any rating and tests have shown that the quantity of solids entering the stack is far below those specified in the ASME Smoke Regulation Ordinance and our local codes. The Vibra-Grate was installed without a dust collector and it is obvious that no collector is needed.

"Comparison of the operating efficiency of the Vibra-Grate with that of our former stoker is very much in favor of the Vibra-Grate. Need for maintenance has been at an absolute minimum."

AE Vibra-Grate Stoker (completely water-cooled) brings a combination of advantages never before approached in stoker history. Nearly 100 Vibra-Grates are now in operation in Europe, the Middle East and the U.S. If you are shooting for the last word in stoker efficiency, write us for full information.

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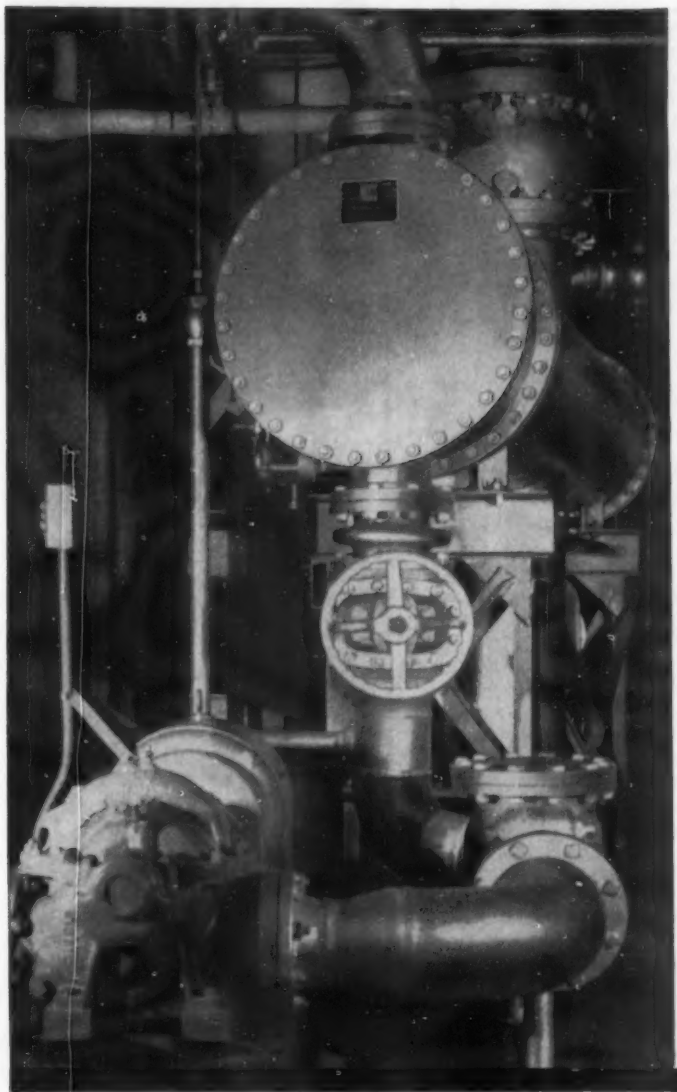

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BURNERS, STOKERS

Continued from page 210

can increase the draft to give a positive pressure in furnace and boiler. This helps the chimney pull gas through the steam-generating unit. But be sure that setting and boiler casing are air tight. Otherwise, the hot gas will be forced out of any openings. It will soon overheat and damage adjacent boiler parts that are not watercooled.

Casing construction must also be strong enough to withstand the internal air pressure, which may be 20 to 30 in. of water. Special seals around soot blowers, damper controls, ash-removal doors and other necessary openings prevent escape of hot gas.

Induced draft. The usual alternate to operating the furnace under pressure is to install an induced-draft fan that removes combustion gas as it is generated. Fan inlet dampers or fan speed are adjusted to maintain a furnace draft of 0.1 or 0.2 in. of water. As boiler rating is changed, fan output is varied to maintain a slight suction in the furnace. In tall furnaces, draft at bottom of the furnace may be considerably higher than 0.1 or 0.2 in. as hot gas in furnace produces chimney action.

The induced-draft fan reduces the required forced-draft fan pressure, but it has to be larger than the forced-draft fan. Gas that induced-draft fan handles is much hotter and, therefore, has greater volume. Some installations designed for pressure operation use the induced-draft fans only for starting. Or they may employ them only for emergency conditions where a setting leak or necessity for hand lancing of boiler surfaces requires maintaining a suction on the setting. You can usually get a power saving by operating with the induced-draft fan shut down.

Forced-draft fans are often on top of boilers, where they can draw in the warm air from around the boiler. This increases boiler efficiency slightly, but fan capacity is slightly decreased with the warmer air. Fan capacity is also affected adversely if the building is so tightly closed that a suction is created within it. This suction must be overcome by the induced-draft fan to pump the flue gas out of the building.

Other hazards include possible collapse of doors or windows, and pulling gas from a common stack into an idle boiler. You need adequate air openings near the forced-draft fan suction to keep suction on building low. This will improve boiler capacity and also enhance plant cleanliness because less dirt-carrying outside air is pulled into offices, turbine rooms, shops and other areas..

Most boiler installations use air heaters that reclaim heat from the flue gas

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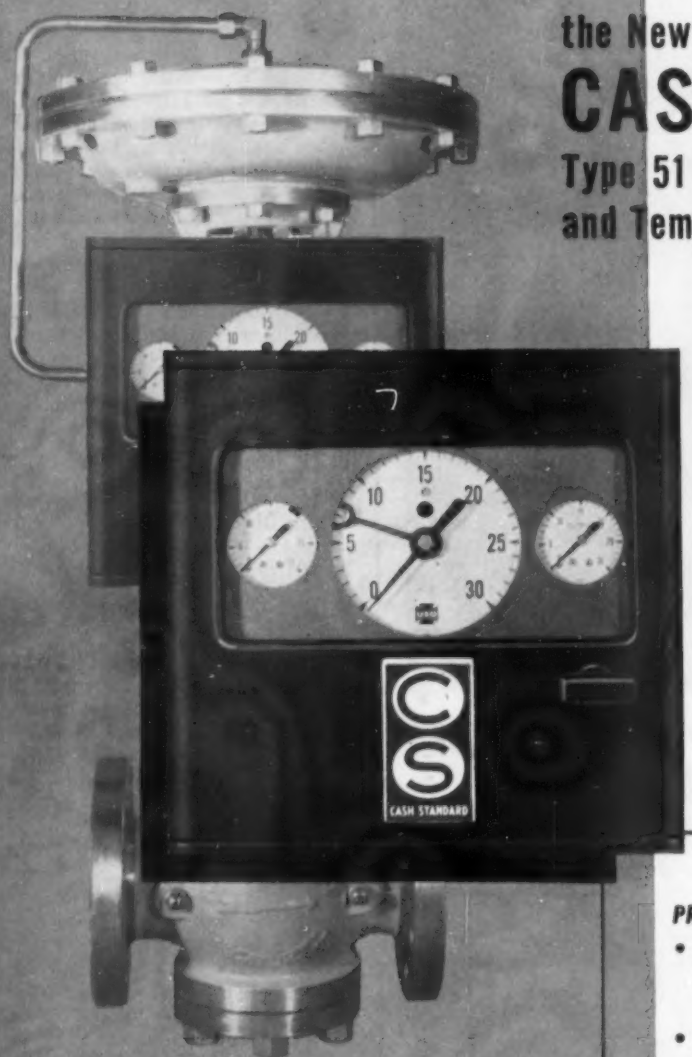

Cash Standard Type 51 Pilot can be ordered separately or mounted on a Cash Standard Control Valve (Illustration is one example).

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- Unit construction
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- Available with proportional, plus automatic reset action
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  Pressure ranges: 0-15 to 0-10,000 psi also 0-30" H_2O and 0-30" Hg vacuum

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BURNERS, STOKERS

Continued from page 214

before it is discharged to the stack. The pressure loss in air heater, air and flue-gas circuits must be offset by increased pressure output from forced and induced fans. Usually, a reduction of 40 F in exit-flue-gas temperature increases boiler efficiency about 1%.

The hot air promotes more rapid fuel ignition, but air ducts should be insulated to prevent heat loss and possible injury to personnel. Damper and burner vanes sometimes stick because parts expand at high temperatures.

Some of the preheated air may be drawn off to heat coal in coal dryers or pulverizers. In pulverizers, additional fans force the coal-air mixture into the furnace through the burners. Some 10 to 20% of the total air for combustion is usually taken through the pulverizers. Special primary-air fans may be used to force air through a separate section of the air preheater, through pressure-type pulverizers and into the burners and furnace. Small high-pressure fans also supply overfire air jets that may be installed to increase turbulence and rapidity of combustion in spreader-stoker and underfeed-stoker installations.

Air-cooled refractory settings use combustion air to cool brickwork, thus prolonging its life and increasing boiler efficiency. Either the forced-draft fan or a special fan may supply the air. It enters the furnace at the burners, or along the sweep of the flame path where it can be used effectively in the combustion process.

Air supplied should always equal that required for complete combustion. Arrange fan operations and control to balance load between fans and maintain proper air distribution to burners or various portions of stokers.

Fans should operate smoothly and must be well-balanced. Dust or oil deposits on forced-draft fans or unequal erosion on induced-draft fans may cause vibration.

Seals around the circumference of the fan rotor should be even, and set to prevent undue recirculation between fan suction and discharge. Fan cut-off should be properly located to give efficiency and prevent recirculation. Check that air-entry openings to forced-draft fans are free and open. Area on both sides of the fan should be equal if unit is the double-suction type.

Uneven resistance of regenerative-type air heaters caused by deposits, uneven leakage, or other reasons may cause pulsation in both the air-supply system and furnace. Other causes of pulsation and unsteady furnace conditions include a slight deficiency of air,

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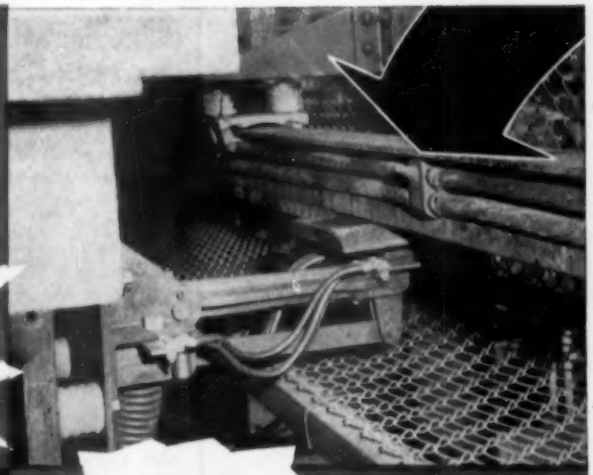

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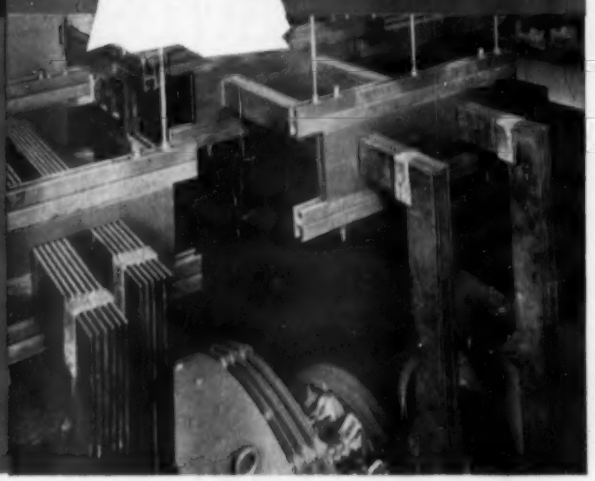

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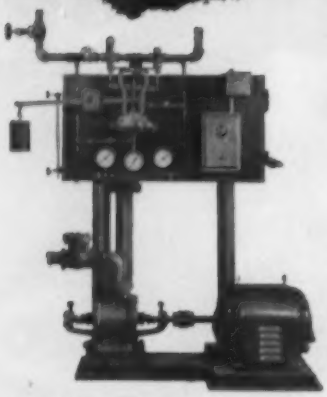

A closed pumping system for returning condensation from heating and processing equipment under pressure directly to boiler at temperatures only 15 to 20 degrees lower than those at operating pressure. For plants using steam pressures between 50 and 250 lbs. Cuts the cost of steam these eight ways:

1. Cuts fuel costs 10% to 25% by completely salvaging condensate and returning to boiler at 300 degrees or higher.
2. Raises production with higher, more uniform boiler pressure, higher temperature steam.
3. Reduces use of raw make-up water 85% to 90%.
4. Cuts maintenance on boilers, steam lines, traps and valves.
5. Improves quality by permitting operation of processing units at peak efficiency.
6. Cuts power used for pumping up to 75%, since system requires only 25 lbs.
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Steam Traps • Feed Water Heaters
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Drainage and Boiler Return Systems

BURNERS, STOKERS

Continued from page 216

too high or too low fuel-air velocity through burner throats.

Unless you use dust collectors ahead of the induced-draft fans, you may get serious erosion of induced-draft fans on coal-burning units. Make perodic inspections to assure that fan wear does not develop to a hazardous extent.

On large installations, using two fans in parallel may avoid excessive size and permit better efficiency at light loads. Shutoff dampers prevent recirculation through an idle unit.

The way the air enters the fan affects its efficiency and capacity. Where inlet vanes or dampers are used for control, efficiency is better than where output is controlled on the outlet. Guide vanes generally direct the air or gas into the fan in the most efficient manner, so inlet velocity assists rather than hinders operation. Improper installation of these vanes or improper turning of inlet control vanes may seriously handicap operation. If fan rotor is replaced with blades slanted in the opposite direction from the original design, capacity will be adversely affected.

Combustion air must be intimately mixed with the fuel, and sufficient temperature and time then given for complete combustion. Air leaking in furnace walls or other openings will probably have little chance to mix with the fuel.

Shortly after furnace gas passes the first superheater or furnace-outlet screen tubes, the temperature will have fallen so low that ignition will not occur even if air leaking into the setting is thoroughly mixed with combustibles. Air leaking into a steam generator is thus of little use so far as helping combustion is concerned. In addition, the extra air increases heat loss and overloads induced-draft fans.

SUDDEN LOAD

Continued from page 97

are as follows:

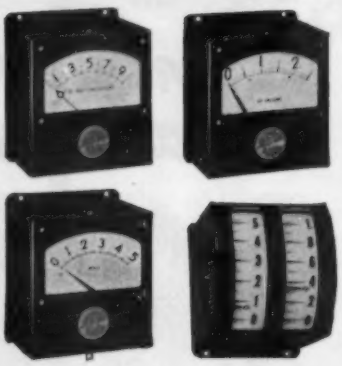
Volume of suction piping—

Common to both pumps	= 600 gal
From separation pump under study	= 107 gal
One pump running	= 707 gal

Balancing-device leakoff is 30 gpm per pump; performance of the pumps is shown in Fig. 3. Table 2 gives the calculations to determine the allowable rate of pressure decay for the entire capacity range of the installation with either one or two pumps operating. Fig. 4 shows these data graphically.

Study of these data shows that the allowable rate of pressure decay starts

CFE DRAFT, AIR PRESSURE AND FLU-TEMP GAGES



Large or small steam generating plants, whether coal, oil or gas-fired can be more efficiently controlled by the use of CFE Gages. Draft Gages indicate amount of air furnished to firebox and condition of fuel bed —Air Pressure Gages show windbox pressure—Flu-Temp Gages measure temperature of flue gases. The use of CFE gages provides the operator with information enabling him to correct improper boiler conditions for increased boiler efficiency and greater fuel economy.

CFE Gage Features:

- **Single or multi-pointer**
- **Clear, easy-to-read dials**
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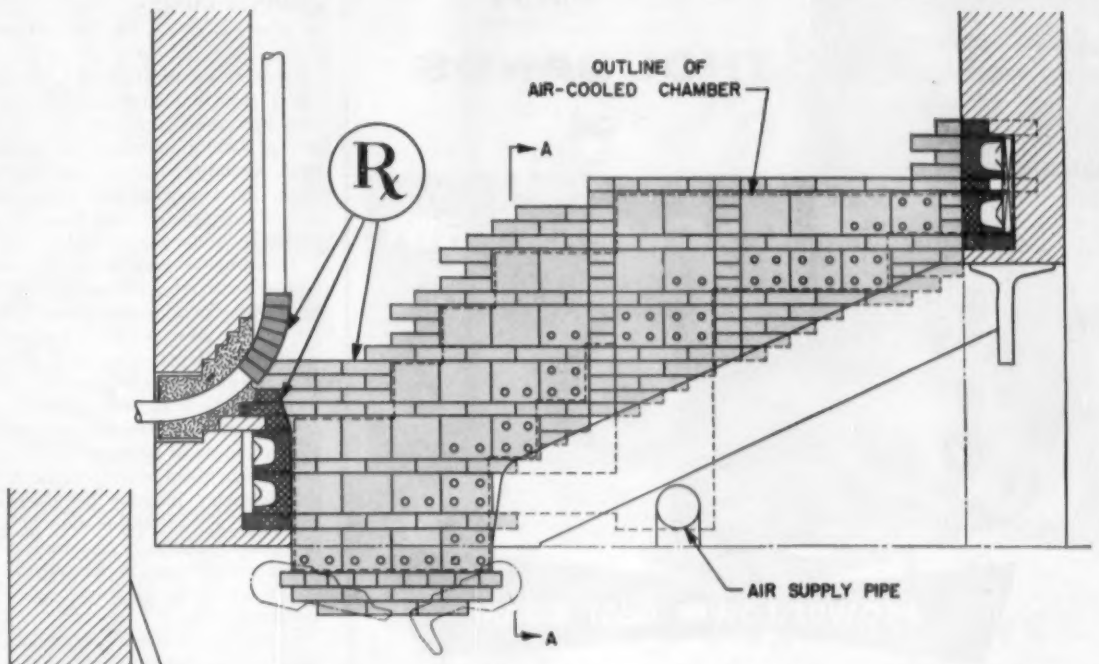

In this multiple retort stoker fired boiler CRYSTOLON *engineered and prescribed* refractories provide complete air-cooled wall coverage, besides safeguarding the water tube bridge wall. A good example of how CRYSTOLON shapes may be adapted and combined for applications in many different boiler designs.

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Due to careful bond selection, CRYSTOLON refractory products have a much higher useful temperature range than conventional refractories, with greater resistance to slag penetration and fly-ash accumulation. With this high refractoriness they combine exceptional hot strength, thermal conductivity and resistance to spalling and abrasion. These valuable properties show how expertly they are *engineered* to assure maximum protection against chemical and mechanical attacks by different types of fuels — and why they are *prescribed* for more efficient, lower cost boiler operation on a wide variety of applications.

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how Norton *engineered and prescribed* refractories may provide the Rx's you need for better, more economical boiler performance. For your copy of *Refractories for Heat and Power,* write to NORTON COMPANY, 449 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co. Ltd., Toronto, Canada.

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SUDDEN LOAD

Continued from page 218

at zero at no flow (infinite residence time), rises to a maximum at about 700 gpm per pump, and then falls back to zero at 1250 gpm, where the available npsh exactly balances the required npsh. But remember that pump operation at abnormally low flows is prevented by automatic controls.

Assuming a maximum permissible flow without recirculation of 125 gpm per pump, the allowable pressure decay rate at low flows is 14.5 ft per min, or about 6.1 psi per min. At low loads, only one pump may be running. Under these conditions the residence time for any flow is effectively doubled and the allowable rate of pressure decay shown in Fig. 4 is about halved. Since such a situation may increase the danger of operation, the allowable rate of pressure decay must be determined for single-pump operation, as well as multiple-pump operation where more than one pump is used.

In some cases these calculations will show an experienced engineer that the allowable decay rate will never be approached by the actual rate, and that the installation is adequate. Should there be any doubt of this adequacy, a more complete analysis of the actual decay rates must be made.

The next article in this series will analyze the factors affecting the actual rate of pressure decay in a direct-contact heater.

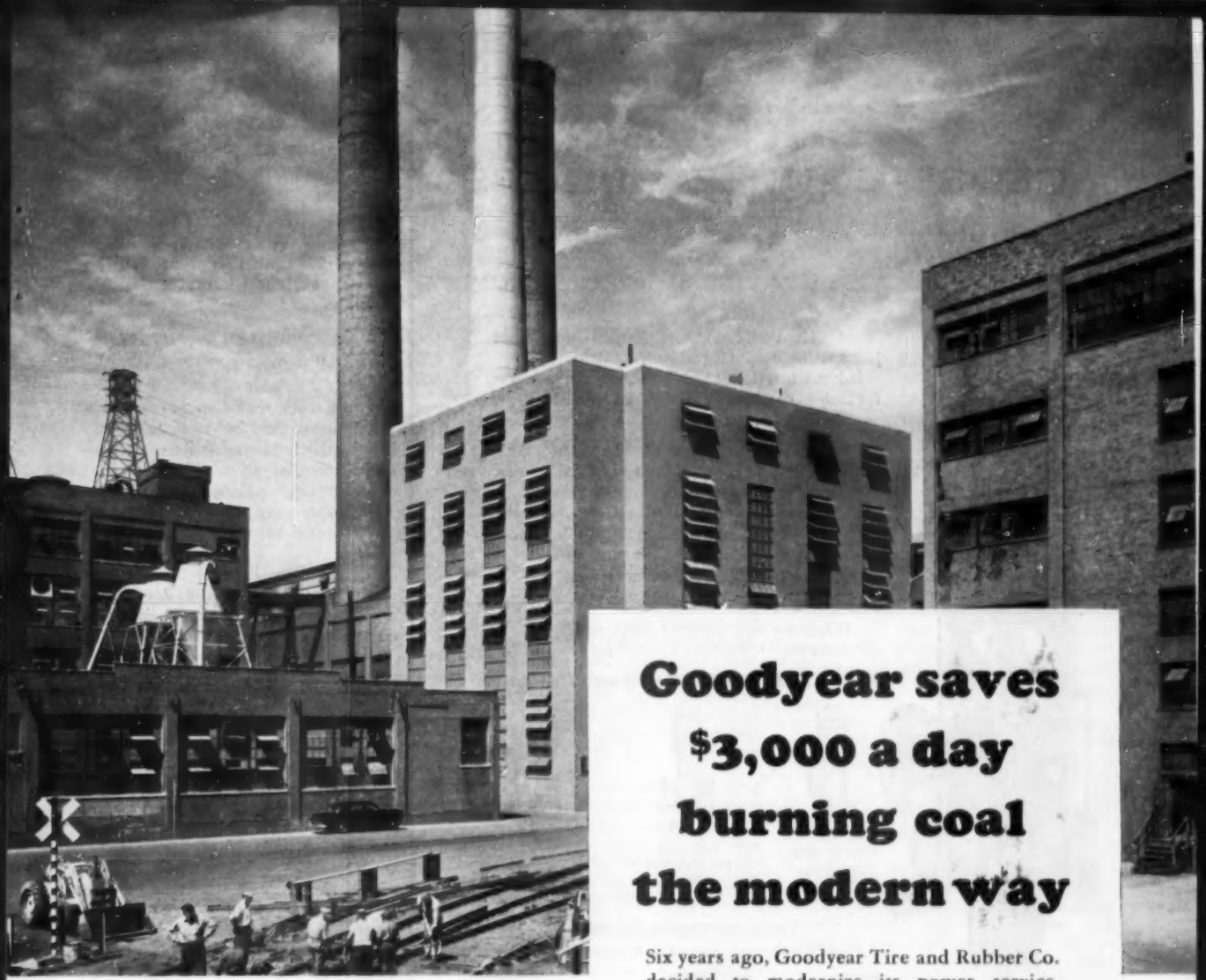
NUCLEAR RESEARCH

Continued from page 105

terials and experiments to be irradiated are placed in containers in the high-radiation flux around the cobalt-60. The water serves as a transparent biological shield.

The radiation source consists of small cylinders of neutron-activated cobalt with a specific activity of 3 to 5 curies per gram. These cylinders are held in thin-walled stainless-steel tubes, 8 in. long and somewhat more than ⅛ in. in dia. About 40 of these tubes produce the 2000 curies. The tubes may be arranged in a variety of geometries to fit the materials being irradiated. The highly flexible design allows: working with unusually large specimens, subjecting small specimens to very intense radiation, or irradiating materials in a continuous-flow system.

Radiation-flux measurements have not been completed, but preliminary results indicate about 10^6 roentgens per hr may be obtained in a 300-cu-cm volume



Goodyear saves $3,000 a day burning coal the modern way

Six years ago, Goodyear Tire and Rubber Co. decided to modernize its power service. Among other considerations, 70% of the firm's steam-generating equipment was over 30 years old. As a result, operating efficiency was only 65%. Power needs at Goodyear's Akron plants ran so much greater than capacity that additional power had to be purchased. Goodyear engineers and engineering consultants, Sargent & Lundy, were called in to study the problem and recommend a solution.

Now two 220,000 lb.-per-hr. boilers have replaced six 50,000 lb.-per-hr. units. Coal and ash handling are automatic. Controls are fully automatic. And not only have these and other changes resulted in dependable power service, but steam generating efficiency is now 82%—saving Goodyear $3,000 a day. For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

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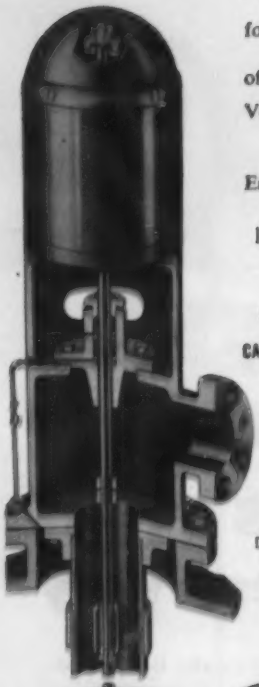

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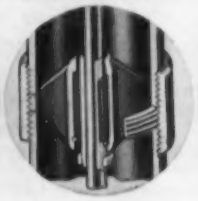
The packing assembly is simple and effective. It is easily accessible and consists of a packing container, lantern ring, packing rings, pressure relief bushing, gland, fluid by-pass and lubrication fittings. Mechanical shaft seals also available.



Outstanding feature of bearing assembly is removable stainless steel shaft sleeve. This prevents shaft wear and bearing journal corrosion, and is easily replaced without special tools. You simply remove the old and slip on the new which is secured by a stainless steel collet.

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NUCLEAR RESEARCH

Continued from page 220

and $3x10^5$ rph in 2000 cu cm with the 2000-curie source. Orders have already been placed for additional cobalt-60 to increase the source intensity to at least 4000 curies. Ultimately the full design capacity of 10,000 curies will be installed in the facility.

RADIOISOTOPE LABORATORY

This all-purpose facility occupies an area 72x30 ft with offices, locker room, counting room, workshop and two large laboratories. One low-level laboratory is designed for experiments with radioactive material up to 10 millicuries; the other intermediate-level lab houses experiments using up to 1000 millicuries of radioactive material emitting gamma rays.

The intermediate-level lab has four radio-chemical hoods and floor space for special experiments. A steel-and-concrete storage vault can hold 108 different radioactive samples with a total radiation level equal to about 10 curies of a 1-mev gamma emitter. A 9-ft-deep concrete water tank provides additional storage capacity and serves as a hot cell for crude manipulations. This tank can hold several hundred curies of a 1-mev gamma emitter. A 10-curie cobalt-60 source is used mainly for radiography.

The low-level lab has two regular radiochemical hoods and two California-type hoods for work with gas trains; also two dry boxes, two laboratory benches, and a variety of lab equipment.

For detecting and measuring radiation there are:

1. Well-type sodium iodide, thallium-activated scintillation crystal for gamma-ray detection.
2. End-window Geiger-Muller (GM) tubes for beta-particle detection.
3. GM dip tubes for beta-particle and gamma-ray detection in solution.
4. Gas-flow proportional counter for detection of alpha particles and low-energy beta particles.

Thin end-window GM tubes, with output signal transmitted through a rate-meter and loud speaker, monitor the area and personnel. A number of alpha and beta-gamma detection meters are available for general area surveys.

These lab facilities are available for radioactive-tracer studies, radiochemical analysis, and research and development of instruments using radioisotopes for applications in measuring thickness, density, position of mechanical parts, etc. About 50 individual shipments of radioisotopes per year are currently being used at Battelle in these research fields.

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HALL LABORATORIES, INC.—A SUBSIDIARY OF HAGAN CORPORATION, PITTSBURGH, PENNSYLVANIA

Hall Industrial Water Report

VOLUME 3 OCTOBER 1955 NUMBER 5

It Takes a Lot of Water Conditioning To Manufacture Paper

Ten billion tons of water are required annually for many uses in the papermaking industry. Production has increased from less than one ton per day in the first mill in the United States to 26,656,000 tons in 1954. Water-connected problems of all kinds are handled in over two hundred papermaking plants by Hall service engineers.

Pollution Abatement Program Cited by State Authorities

In connection with its waste disposal problem, an eastern paper manufacturer with the advice of Hall Laboratories set up an investigative and remedial program supervised by Hall staff engineer Herman A. Reda.

The plant had been discharging its industrial waste waters into a waterway supplying a city of 130,000. Pollution was so severe that septic conditions developed when there were periods of low flow. The fact that potable supplies were affected made the situation quite serious.

The removal of contamination, required by the state, was accomplished by utilizing air flotation units to clarify the water and remove the pulp fiber. This equipment functioned so efficiently that both the water and the fibers of pulp could be re-used. The selection of this equipment was based on pilot plant studies which indicated a 97.1 percent removal of suspended solids and a 95 percent reduction in oxygen consuming material.

$100,000 per year is the plant's estimate of the value of the reusable pulp recovered by the in-plant changes and treatment processes recommended by Mr. Reda. Sufficient clarification of white water to permit re-use on the paper machines reduced the plant over-all water consumption.

The reduction of wastes at their sources was, of course, one of the most important results of this work. In their report to the General Assembly of Delaware, the Commission stated that the cooperation received from industry in this particular study, investigation, and follow-up was most satisfactory and exemplary.

Maintenance Cost Reduced

A Canadian newsprint plant was running efficiency tests throughout the plant. At the suggestion of Hall engineer J. C. Skerrett, the plant carried out a three-month test on a paper machine to determine the effect of Hagafilm® in improving heat transfer by cleaning out old corrosion products and controlling return line corrosion.

Pleased with the results of this test, the plant decided to run a test on their Flakt dryer, a separate unit, where leakage due to corrosion was a problem. Overtime for weekly welding of the interconnecting piping of the steam and condensate headers was a costly item.

Leaks stopped within one week after a Hagafilm feed of 2ppm was started, and since there has been no recurrence after six more weeks of operation, it is obvious that maintenance has been reduced to almost the vanishing point.

Hall Engineer Reports on Service

Putting a new boiler into operation can bring up some unexpected problems as the following reports from a Hall engineer on another paper plant show.

Discussed recommendations outlined in my letter to the plant. Lined up plant for boiling out new boiler. Also discussed variations in raw water characteristics.

Returned to plant for initial operation of hydrogen zeolite unit. Suggested that plant start to decrease rate of blowdown as more of the blended water is used. Boiler-water test results showed deficiencies of phosphate and sulfite. Had them increase feed of chemicals.

Went over operation of sodium-hydrogen zeolite unit setup. Found that system was cut into service only twice a day as the clear well level did not drop appreciably. Checked clear well water to determine whether or not raw water was getting into the system and found it O.K.

Learned that the plant had been operating for four days with an acid boiler water. Investigation indicated the cause to be faulty operation of the flow control valve. Immediately cut off the hydrogen zeolite unit and went to straight sodium zeolite make-up.

Called to check on plant since we eliminated the acid in the boiler water. Boiler-water alkalinities now around 16 ml and plant is again blending the sodium-hydrogen zeolite water.

A while ago I alerted the plant to the fact that something was wrong in the setup because of unexplainable high alkalinity and high phosphate consumption. My checks on the clear well and condensate revealed nothing. However, about ten days ago, things became very upset and clear-well water indicated contamination. Investigated and found that main sewer line carrying backwash water from raw-water filters was broken and that there were cracks in the clear well. The sewer runs alongside the clear well. Contamination occurred whenever level in the clear well was low, allowing water to seep in.

Director of Hall Laboratories Receives A.S.T.M. Award

Dr. Everett P. Partridge haa received the 1955 Max Hecht award of the American Society for Testing Materials for "30 years of outstanding contributions to the technology of industrial water."

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information write, wire or call Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

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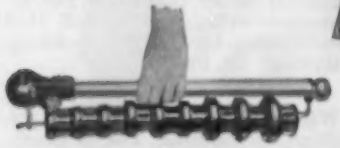

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STEAM TRAPS

Continued from page 121

Strong, Carlisle & Hammond
(continued)

But there is another point I consider even more vital. "How little" condensate a trap will handle efficiently is much more important than "how much."

Almost any trap operates satisfactorily with plenty of condensate. The real problem occurs when traps go for long intervals with practically no condensate.

Surveys of industrial applications show that total trap capacity in an average plant is from 20 to 50 times the total steam consumption. The average trap then runs from 2 to 5% of maximum capacity. But some traps may operate close to full-load rating, so it is reasonable to assume that many function at less than 1% of maximum capacity.

Selecting traps so much oversized is not the result of poor practice or lack of understanding. Engineers are simply faced with complex capacity problems. For example, they can size drip traps to have enough capacity to handle the condensate from the steam required to bring the line up to temperature within a given period. Or they can calculate radiation of the bare pipe. The condensate rate determined by either method is then multiplied by a safety factor. Trap is selected on this basis.

Many serious accidents have resulted from water hammer caused by sudden opening of a steam valve into a cold line that was not properly trapped. So engineers are generous in sizing traps for drip service, separators, etc.

After the line is fully insulated, and up to operating temperature, normal rate of condensate may be only a fraction of a percent of the trap capacity. In superheat lines, separators carrying superheat steam and other such drip service on superheat, there may be long periods when there is no water at all.

Traps suitable for this wide range of condensate and pressure are now available. The prudent engineer might well give careful consideration to "how little" as well as "how much" his traps will handle satisfactorily.

R L Clark, *manager,*
Steam Specialty Division

Yarnall-Waring
(begins on p 121)

Then live steam would reach the traps, causing intermittent rather than continuous discharge, and they could not obtain maximum rated capacities.

It would be interesting to know if Bogart maintained temperature of condensate throughout each test run, at the value on which manufacturers' ratings were based. Condensate temperatures

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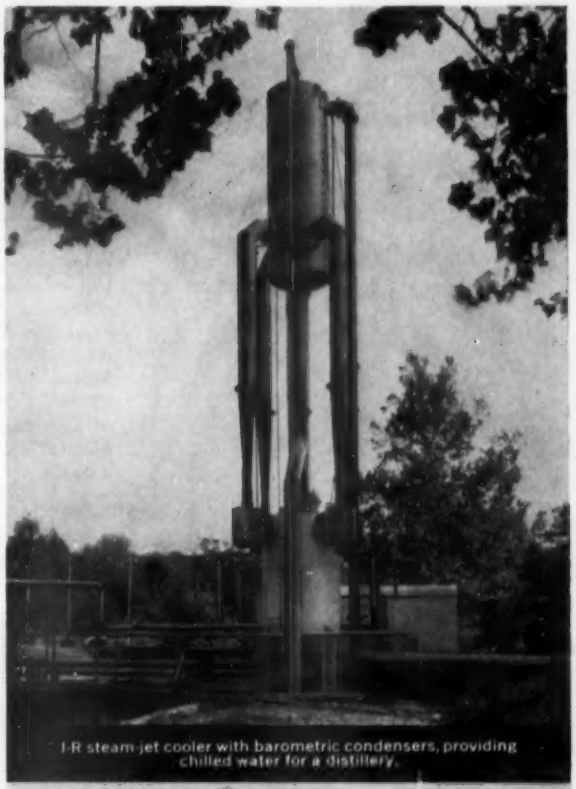
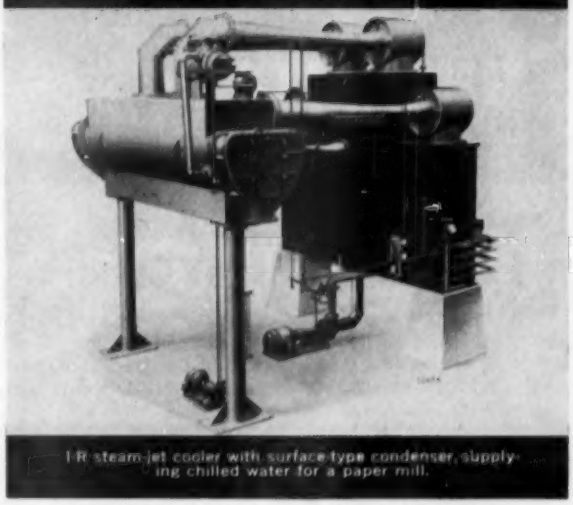


I-R steam-jet cooler with barometric condensers, providing chilled water for a distillery.



I-R steam-jet cooler with surface-type condenser, supplying chilled water for a paper mill.

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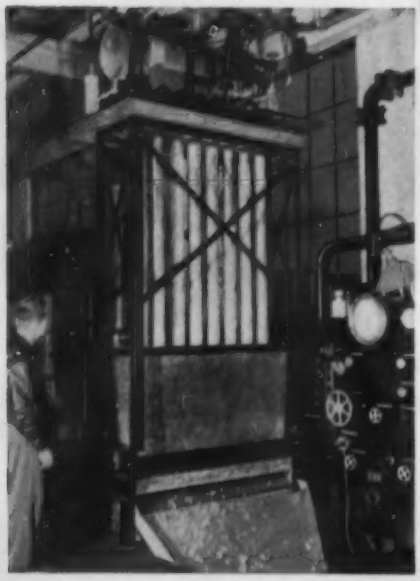

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STEAM TRAPS

Continued from page 224

higher than those specified would give lower experimental capacities.

Although major trap manufacturers publish the conditions on which capacities are based, not all use the same temperature. There is nothing misleading about this if you consider that the primary purpose is to select the proper-size trap after determining required capacity according to manufacturer's instructions.

Required capacity equals actual condensate load multiplied by a recommended safety factor. Safety factors compensate for the variable and abnormal operating conditions peculiar to each type of steam equipment.

The published ratings fulfill their intended purpose. But they have a definite shortcoming in not being based on the same condensate temperature. As Bogart pointed out, this prevents users from making direct comparisons of capacities between various makes. A uniform basis for rating would overcome this limitation.

There are a number of possible conditions on which ratings can be established. One of these is condensate at steam temperature. As the capacity of any trap decreases with increase of condensate temperature, this basis represents the worst operating condition that could be encountered.

But our experience indicates that for a majority of applications condensate reaches a trap at a temperature below that for saturated conditions existing at the inlet. Therefore, we believe steam-temperature capacities are not indicative of general operating conditions.

Also, there are some types of traps that do not operate at steam temperature, but require subcooling of the condensate before discharging. For these reasons, we feel it is not practical to use steam-temperature condensate as a general standard for rating capacity.

Another possible reference point is condensate at 200 F or less. This is commonly referred to as a cold-water rating. It is indicative of startup conditions when steam equipment is cold and condensate loads are exceptionally high. Corresponding condensate temperature is far below saturation temperature.

Capacities established on a cold-water basis are greatly in excess of what could actually be realized in normal operation when equipment is up to temperature, and condensate reaches the trap considerably closer to steam temperature.

To apply cold-water ratings to actual operating conditions, extremely large safety factors would be needed. Even so, it is doubtful whether the effects

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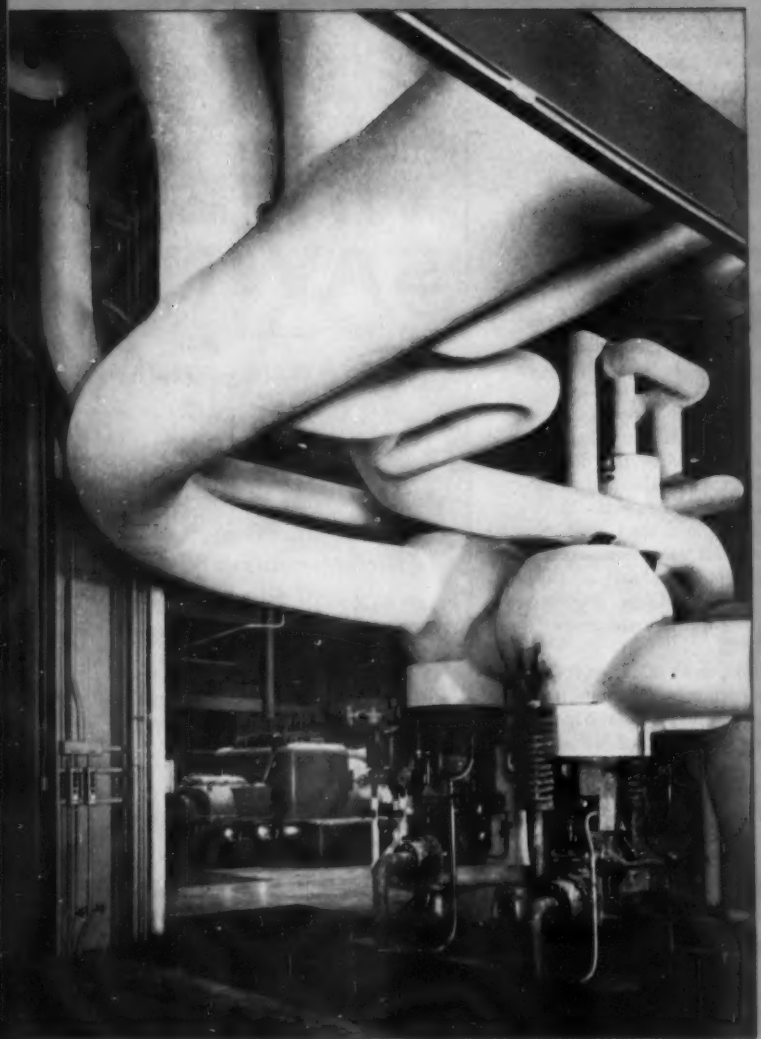

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STEAM TRAPS

Continued from page 226

on capacity of hot condensate flashing in the discharge piping could be fully compensated for in such a manner. Therefore, we believe that cold-water ratings are not suitable as a standard.

One basis of rating that is quite representative of conditions for general applications is condensate 30 F below saturation temperature corresponding to pressure at the trap inlet. Capacities determined on this basis have been readily adapted to all types of operating conditions with a limited range of safety factors.

We feel that 30 F below steam temperature represents a good basis for a standard for rating trap capacity.

If all capacities are to conform with a standard, it would be advisable to outline test procedures to be followed and describe suitable equipment for determining the capacities. If such information were now freely available, the individual standards already established by major manufacturers would be effective. We believe that with the aid of such data Reader Bogart could have avoided most of the discrepancy between his test results and the manufacturer's published information.

A standard along the lines suggested above would let users compare various traps on a common basis of capacity. It would also facilitate selecting the most suitable unit for a specific application.

In addition, any evaluation tests could be conducted on a common basis resulting in more reliable conclusions. We believe that establishing an industry-wide standard for rating trap capacities would be an important advancement in the field.

E W Wales, *Engineering Dept*

"Haven't had a tool stolen since I ran these conduits into my tool box and put this sign on it."

WATER SAVING

with

TROUBLE-FREE COOLING EQUIPMENT

● Cools your jacket water for engines or process equipment or electric apparatus. Your closed system keeps free from dirt or maintenance troubles. You can cool air, gases, chemicals, plating baths, quench baths, welding machines, extrusion and drawing machines and hydraulic presses. You get real precise temperatures, save rejections, lower production costs. Use NIAGARA AERO HEAT EXCHANGER cooling with atmospheric air . . . saves water, pumping, piping and power; quickly saves its costs.

Write for Bulletins No. 120 and 124

●

Convenient Units Up To 30,000,000 BTU Capacity

NIAGARA BLOWER COMPANY
405 Lexington Ave., New York 17, N.Y.
District Engineers in Principal Cities of U. S. and Canada

higher loads...
economy fuels...
new
engine designs...

there's one answer for all three of these lubrication problems—

Demands upon the lubricant in stationary industrial engines are increasing. More severe operating conditions caused by heavier loads, new engine designs and the use of economy fuels pose difficult lubrication problems not met by conventional oils. Standard Oil Company introduces a lubricant specifically designed to meet these problems—STANODIESEL Oil M.

STANODIESEL OIL M

STANODIESEL Oil M meets or exceeds the requirements of a lubricant for stationary industrial engines. Here's why:

STANODIESEL Oil M is refined from the highest quality base stock. It has superior stability.

Special additives are blended with this STANODIESEL Oil M base stock. An oxidation inhibitor prevents unwanted increases in oil viscosity and prevents corrosion of bearings. The action of detergent-dispersant additives keeps crankcase, pistons, cylinder walls and other parts clean. Contaminants are kept in suspension and are prevented from depositing. An anti-foam agent makes this oil suitable for use in hydraulic governors. A wetting agent increases the oil's ability to reach and maintain a film on such highly stressed parts as cams and cam followers.

Use of STANODIESEL Oil M means this: less engine deposits, less ring and cylinder wear. Less spark plug fouling when used in gas engines. Eliminates fuel injector and pump sticking caused by deposits on the injector barrel and plunger when fuel and lubricating oil commingle.

You need to know about STANODIESEL Oil M. In the Midwest, call your nearby Standard Oil lubrication specialist. You will receive the information promptly. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD

STANDARD OIL COMPANY (Indiana)

the best is easiest to buy..

AJAX
SPIRAL WOUND GASKETS
are Sold Nationally through
INDUSTRIAL DISTRIBUTORS

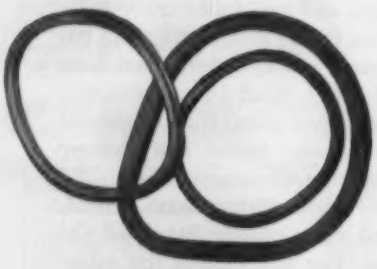
FOR LOWER PRESSURES

Type "H" Ajax Spiral Wound Gaskets with integral wire centering guide answer the demand for a low-priced self-centering ring gasket. Permit the use of the smallest, least-expensive gasket for maximum sealing effect. For pressures up to 600 psi.

FOR HIGHER PRESSURES

Type "S-R" Ajax Spiral Wound Gaskets with solid metal reinforcing ring which locates gasket inside bolt circle, prevents lateral expansion under pressure and acts as a compression gauge for maximum gasket efficiency. For pressures up to 1500 psi.

FOR BOILERS AND ACCESSORIES



Ajax Spiral Wound Gaskets are offered in all sizes and shapes for manholes, hand holes, tube caps, etc., for all standard makes and models of boilers, water walls, economizers and other boiler accessories.

CALL YOUR INDUSTRIAL DISTRIBUTOR
. . . or write for Catalog No. AG-953.

UNITED STATES GASKET COMPANY, CAMDEN 1, NEW JERSEY

FABRICATORS OF FLUOROCARBONS AND OTHER PLASTICS

Representatives in principal cities throughout the world

CON EDISON

Continued from page 101

At a later date, soap slivers were discovered on the antiturbulence screens: They probably found their way there from an unclean pail used during preceding oil inspection.

Still later, fluid was again replaced, this time with the previous charge of *RL 265-A*. Phosphate-ester fluid was finally removed and a new charge of petroleum oil put in its place on July 12th.

Looking back, Beattie notes that the turbine-pump operated about nine months with the *RL 265-A* phosphate-ester fluid, chalking up 5322 service hours. First batch lasted 3667 hours without added defoamer. Second batch of the same type fluid went 1155 hours with several shots of *Dow-Corning 200* and finally had to be removed because of the soap chips. Foaming was an intermittent problem throughout the test.

Why foaming? In a statement made for POWER, A C Stutson of *Socony Mobil* (suppliers of the phosphate-ester fluid used during the test) pointed out that water and dirt in the fluid were definite factors in the foaming picture. Stutson further remarked that when the *Honan-Crane* oil filter was no longer in use, centrifuging alone failed to remove the dust and the dirt that got into the lubricating system.

With petroleum oils, which are lighter than water, centrifuging causes the heavier dirt to go into the water and be removed from the oil. Quite the reverse was found with *RL 265-A*. Since this fluid is heavier than water, dirt remained in it and did not come out when the water was removed. Presence of finely divided dust in a fluid tends to stabilize foaming.

Stutson states further that although defoamers were tried, their effectiveness under the heavy-water conditions were limited to about two to three weeks. Defoamer's effectiveness hinges on the fact that they do not remain in solution but seek the interface. Excessive amounts of water present in this unit, which had to be frequently removed, reduced defoamer effectiveness considerably.

During this experimental period, according to Stutson, it became obvious that water content must be held to a minimum. When 4 to 5% water is present, as with this unit, foaming is bound to be excessive. Stutson further states that if water and dirt in the fluid is held to the normal minimum, as is generally the case in main turbine-generators, fluid operates without excessive foaming. Reason: defoamer's effectiveness continues.

"Used many makes of turbines... PREFERS COPPUS"

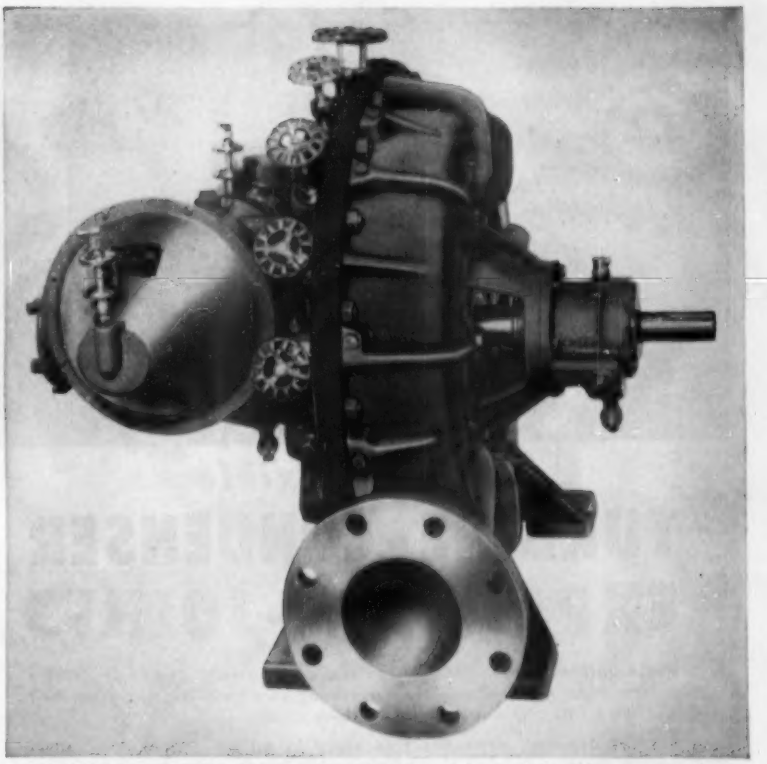
If you want to know about turbine performance, ask an *operator*. He *knows*. And, in the words of one of them:

> "I have had occasion in the past to operate many makes of turbines. The plant in which I am now employed is almost entirely Coppus equipped on our auxiliary equipment. I find your turbines most satisfactory and would like to congratulate you on your design."

Whether you use a Coppus with a regular wheel or wide bucket "L" type you get these *proven* features:

- Turbines rated close to your hp requirements from 150 hp down to fractional. No need to buy a bigger, costlier turbine than your conditions call for.
- A larger number of steam nozzles, controlled individually by manually operated valves.
- Exclusive pilot operated excess speed safety trip supplementing constant speed governor.
- Replaceable cartridge type bearing housings.
- Optional carbon ring packing glands.
- Coppus Steam Turbines ranging from 150 hp down to fractional in 6 frame sizes, *make turbine dollars go farther*. Send for Bulletin 135 on Coppus Turbine.

COPPUS ENGINEERING CORPORATION
170 Park Avenue, Worcester 2, Mass.
Sales offices in THOMAS' REGISTER

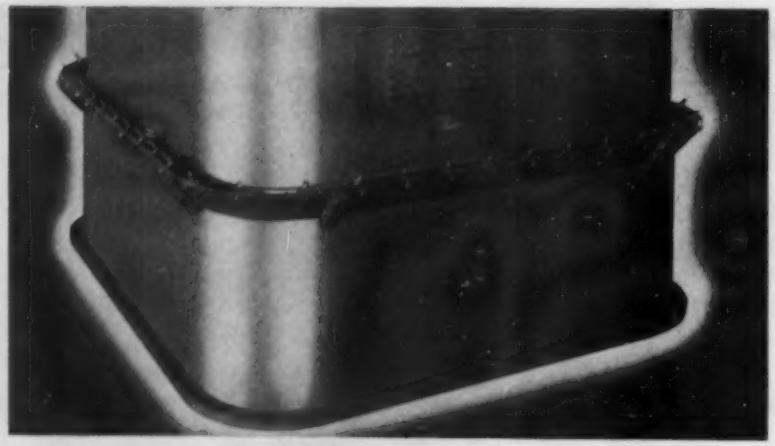


This is the reliable Coppus Turbine furnished with either a regular wheel or wide bucket "L" type wheel.

This wide bucket "L" type wheel is a new development for use where low water rate is essential

This is the regular wheel used on Coppus Turbines which have been so highly satisfactory throughout industry.

COPPUS "BLUE RIBBON" TURBINES

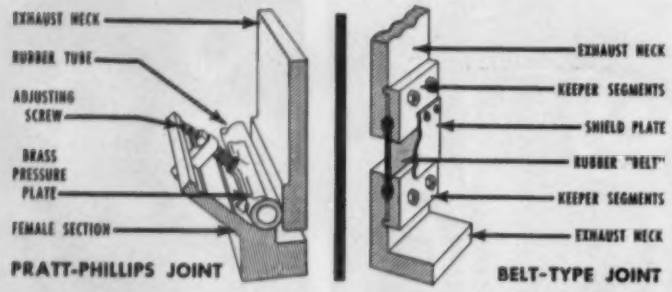


simple-flexible

TURBINE-CONDENSER EXPANSION-JOINTS

Pratt-Phillips joint is ideal flexible connection. Absolutely air-tight under vacuum and steam-tight under exhaust conditions, it is easily installed and sets up no undue strains in the turbine casing.

Rubber element provides flexibility in all directions. The rubber sealing member is held under compression by pressure plates. Protected from oil and sunlight, it lasts for many years. The exclusive Pratt-Phillips design exposes only one-twelfth of the rubber surface to steam.



Easy to install or replace. The rubber element can be installed, removed or replaced in less than three hours on even the largest joints. No special rubber shapes are required; the same type is used on round or rectangular stacks.

Other types of joints available. For installations where space is limited, the belt-type expansion joint is advantageous since it requires no more space than the exhaust stack itself.

The Henry Pratt Company offers complete engineering and manufacturing facilities for exhaust stacks and joints, flues, ducts, butterfly valves and other power plant equipment.

Our engineers can help with your problems...write for full details.

HENRY PRATT

POWER INDUSTRY EQUIPMENT

TURBINE-CONDENSER

Expansion Joints

Henry Pratt Company, 2222 S. Halsted St., Chicago 8, Ill.

REPORTS from the FIELD

Begins on page 160

tribution and application of power in manufacturing plants, commercial establishments and institutions. This embraces fuel handling, combustion, engines, generators, motors, pumps, compressors, mechanical transmissions and electrical controls. Every type of equipment for power plants, from the smallest package boiler to great steam-generating stations, will be represented.

Many exhibitors will disclose products never before publicly displayed.

Canada's 1955 Power Show set for November 8-11

► PAGEANT OF POWER will be the theme for the 1955 version of Canada's Power Show to be held in the Show Mart Building, Montreal, on November 8-11. Scheduled in conjunction with the event is the annual convention of the Institute of Power Engineers, sponsors of the show. Numerous exhibits and four main technical sessions will highlight the show's program.

H O Tiffin, mechanical engineer, Atomic Energy of Canada, Chalk River, Ontario, will present a paper on "Nuclear Power and the Operating Engineer." The discussion will be built on the basis that since the Canadian approach to nuclear power is roughly laid out for the forseeable future, the type of equipment to be operated can be predicted. The talk will cover equipment likely to be used, its operating characteristics and its maintenance problems.

I G Wilkie, manager, RCN (Peacock) Test Plant, Ville LaSalle, Quebec, will present the design and functions of a naval engineering test plant. This will be the first time—because of security reasons—that any of the unique features of the test plant have been disclosed.

Ralph Grossman, Combustion & Power Equipment Ltd, will speak on "Some Effects of the Growing Use of Fuel Oil in Canada." The paper will be substantiated by factual reports from authorities in the industrial and government fields.

The concluding session will consist of a panel discussion by four representatives of the various phases concerned with the construction of a power plant. Business sessions will be held during the afternoons of the four days.

Hungary makes its biggest water turbine

► THE BIGGEST WATER TURBINE ever made in Hungary is nearing completion in the Ganz Wagon factory turbine plant. It weighs 400 tons and has a capacity of 4000 kw. Unit is the first

NOW!

Electronic LIQUID LEVEL CONTROL by FISHER®

Fisher Governor Company widens its scope of liquid level measurement and control with the Fisher "Belmont Series" of capacitance type electronic liquid level controllers.

The "Belmont" can be used on most non-adhesive liquids—chemicals, oil, water, refrigerants, liquefied gases. Operating temperature ranges of the sensing elements are from 500° F. to -425° F. Operating pressure range is vacuum to 50,000 psi or higher.

Only two simple adjustments for liquid and differential control.

Fisher Governor Company has purchased the Thermo Instruments Company, Belmont, California, which has manufactured and marketed the "Belmont" liquid level control the past ten years.

Write for Bulletin F-100

FISHER GOVERNOR COMPANY • Marshalltown, Iowa

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

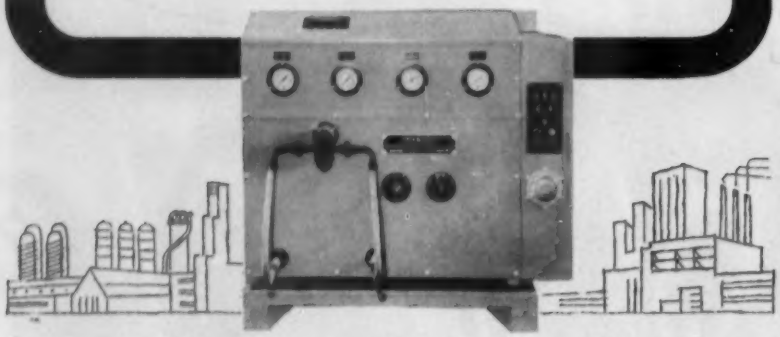
FISHER

Our 75th ANNIVERSARY

Designed for all industries
used in all industries...

the **PEABODY PK-54**

AUTOMATIC BURNER



for oil, gas, or combination

The Peabody PK-54 Burner has achieved full recognition throughout industry as an *efficient, safe, dependable* unit for any boiler application. Completely factory assembled with integral forced draft fan — *fire-tested* and calibrated before shipment, the PK-54 cuts installation time, saves space and holds manpower requirements to a minimum. Sized for boilers up to 42,000 lbs. steam per hour. With complete combustion sequence, safety and interlock controls, the PK-54 is the modern answer to industry's need for lower costs plus dependable, economical performance.

Industries utilizing the PK-54 are:

BREWERIES	SCHOOLS	FOOD PROCESSORS
HOSPITALS	HOTELS	TEXTILES
LAUNDRIES	UTILITIES	CHEMICALS
DAIRIES	PLASTICS	AND MANY OTHERS . . .

Complete details of how Peabody's PK-54 can fit your combustion requirements available on request.

PEABODY ENGINEERING CORPORATION
580 FIFTH AVENUE, NEW YORK 36, N.Y.
OFFICES IN PRINCIPAL CITIES
PEABODY LIMITED • LONDON, S.W. 1, ENGLAND

6-104

REPORTS from the FIELD

Begins on page 160

of three to be installed at the new Tiszalok power works.

The dam at Tiszalok will use the Tisza river water for electric power and also provide water for an irrigation network in eastern Hungary.

Calendar of Events

Oct 17-19—Engineer's Society of Western Pennsylvania, 16th annual water conference. Hotel William Penn, Pittsburgh. Details from Society Office, Hotel William Penn, Pittsburgh 30, Pa.

October 17-21 — American Welding Society, national fall meeting. Bellevue-Stratford Hotel, Philadelphia. Details from AWS, 33 W 39th St, New York, N. Y.

Oct 17-21—National Safety Council, 43rd national safety congress and exposition. Conrad Hilton, Congress, Morrison and LaSalle Hotels, Chicago. Complete information from R L Forney, NSC, 425 N Michigan Ave, Chicago 11, Ill.

Oct 24-25—Steel Founders' Society of America, fall meeting. The Greenbrier, White Sulphur Springs, W. Va. Complete information obtainable from SFSA, 920 Midland Building, Cleveland 15, Ohio.

Oct 31-Nov 2—National Lubricating Grease Institute, 23rd annual meeting. Edgewater Beach Hotel, Chicago. Further details from NLGI, 4638 J C Nichols Parkway, Kansas City 12, Mo.

Oct 31-Nov 3—National Association of Corrosion Engineers, Northeast region fall meeting. Hotel Niagara, Niagara Falls, N. Y. Details from J M Fouts, program chairman, N. Y. Telephone Co, 63 E Delavan Ave, Buffalo 8, N. Y.

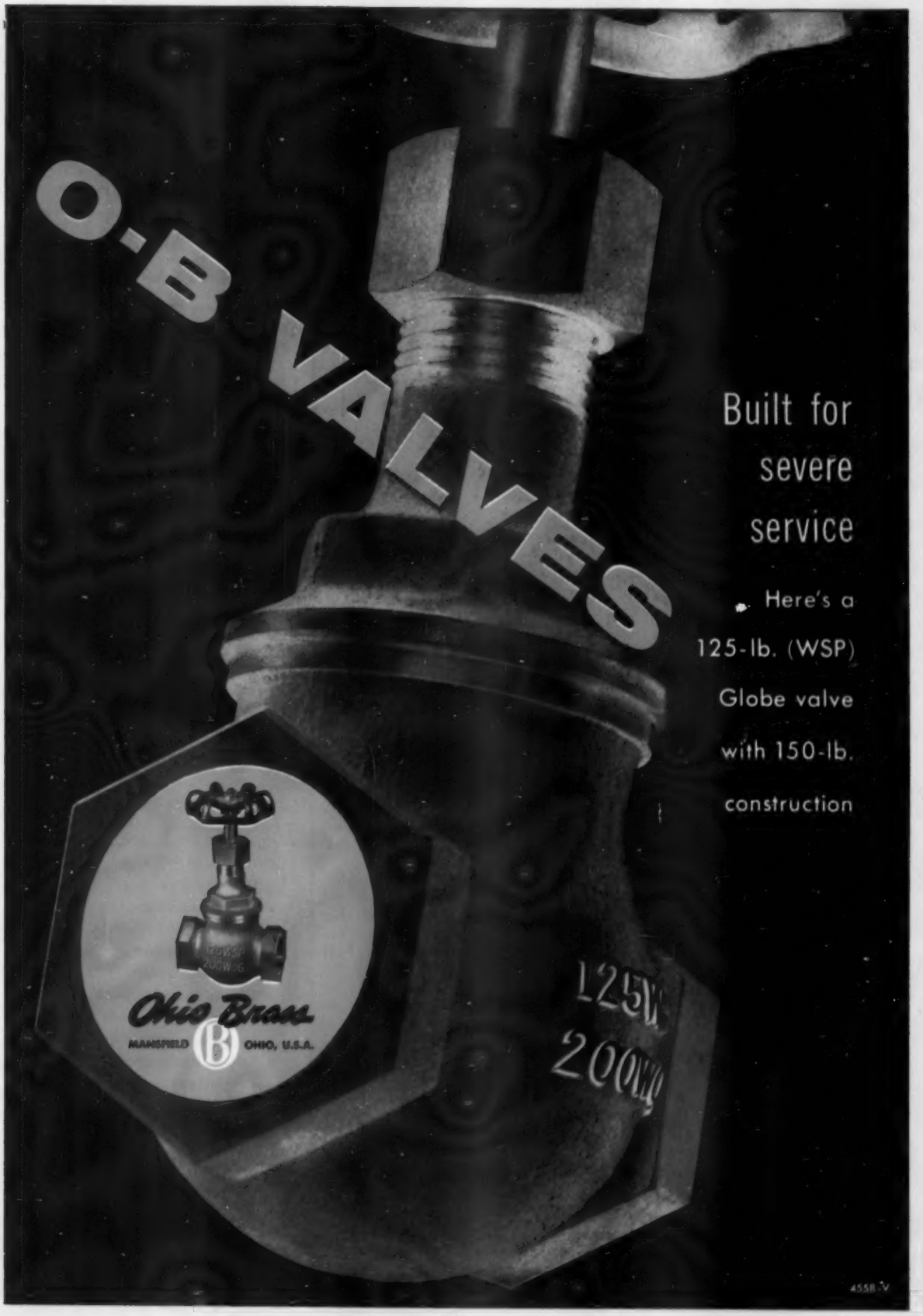
Nov 1-5—World Symposium on Applied Solar Energy, sponsored by Stanford Research Institute, Assn for Applied Solar Energy and the University of Arizona. Westward Ho Hotel, Phoenix, Ariz. Complete information from Public Relations Dept, SRI, Stanford, Calif.

Nov 8-11—Institute of Power Engineers, Canada's 1955 Power Show. Show Mart Building, Montreal. Complete information obtainable from IPE, 410 Bloor St East, Toronto 5, Ontario.

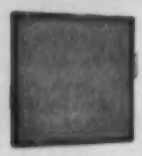
Nov 13-18—American Society of Mechanical Engineers, diamond jubilee annual meeting. Congress, Conrad Hilton and Sheraton-Blackstone Hotels, Chicago. Details from ASME, 29 W 39th St, New York 18, N. Y.

Nov 14-18—American Society of Mechanical Engineers, Chicago exposition of power and mechanical engineering. Chicago Coliseum. Full information from ASME, 29 W 39th St, New York 18, N. Y.

(Continued on page 236)


O-B VALVES
Built for severe service
Here's a 125-lb. (WSP) Globe valve with 150-lb. construction
Ohio Brass
MANSFIELD
OHIO, U.S.A.
125WSP
200WOG
4558-V

HERE'S THE SEQUEL TO "...or equal"



When you see this specification..."FAR-AIR® filters or equal" remember that these filters *have no equal*. Substitutes mean contributions to the junk pile and higher eventual costs, so it pays to install the finest—FAR-AIR.

In FAR-AIR you get filters that handle more air with greater efficiency. Because of their greater dirt-holding capacity, you save up to 60% in maintenance. The "lifetime engineering" of FAR-AIR filters with their heavier frames, reinforcing rods and other features, insures that each unit will continue to operate with replacements virtually eliminated.

Yes, you'll want to use FAR-AIR filters eventually, so why not install them initially. Write for complete catalog information to:

FARR COMPANY, P.O. Box 45187, Airport Sta., Los Angeles 45, Calif.

Send for your copy showing complete specifications on the FAR-AIR line of quality filters.

FARR COMPANY
NO COMPROMISE ON QUALITY
Los Angeles, New York, Chicago
New Orleans

REPORTS from the FIELD

Begins on page 160

Nov 16-18—Society for Experimental Stress Analysis, 1955 annual meeting, Sheraton Hotel, Chicago. Further information obtained by writing Dr W M Murray, SESA, P.O. Box 168, Cambridge 39, Mass.

Nov 16-18—Steel Founders' Society of America, 10th annual technical and operating conference. Hotel Carter, Cleveland. Details from SFSA, 920 Midland Building, Cleveland 15, Ohio.

William "Wink" Quarles, Power's Atlantic District manager

► WILLIAM WASHINGTON QUARLES, Atlantic District manager for POWER since 1944 and associated with McGraw-Hill publications since 1926, died of a heart attack at his home in Darien, Conn., Aug 19.

Born in Selma, Ala. on Dec 29, 1899, he was graduated from Marion Military Institute, Marion, Ala., and from Massachusetts Institute of Technology, class of 1924.

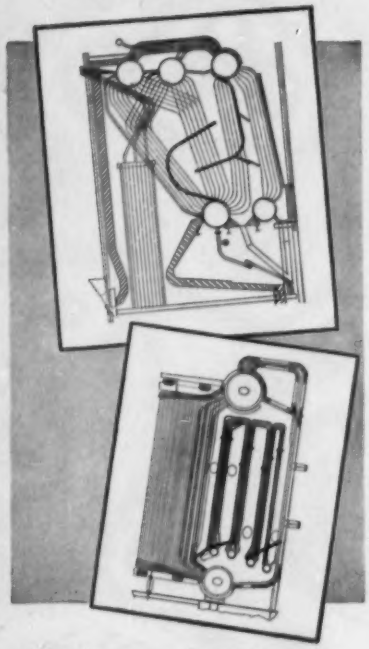
He joined McGraw-Hill in 1926, after two years with Ingersoll-Rand Co, and was sales representative for two McGraw-Hill magazines, *Chemical Engineering* and *Food Engineering*, in the Philadelphia area.

During World War II he served from 1941 until 1944 in the Coast Artillery and was discharged with the rank of lieutenant colonel. He returned to McGraw-Hill and was appointed the district manager of POWER in the New York office.

"Wink," as he was known to his many friends in industrial advertising circles, was a member of the University Club, New York; the MIT Club of New York, and the Wee Burn Country Club, Darien.

He is survived by his widow, the former Catharine Thomas of Philadelphia; a daughter, Sherrie Ellen Quarles; and a brother, George P Quarles of Selma.

ONLY ENCO BAFFLES give you all these COST CUTTING FEATURES



These important fuel-saving maintenance-reducing features are obtainable with Enco boiler baffles—*and only with Enco baffles.*

- **Streamlined gas flow**
- **Uniform gas flow**
- **Elimination of bottlenecks**
- **Reduced draft losses**
- **Higher heat transfer**
- **Cleaner heating surfaces**
- **Less use of soot blower**
- **Special provision for expansion**
- **Easy tube replacement**
- **Adaptable to any water-tube boiler, fired by any fuel**

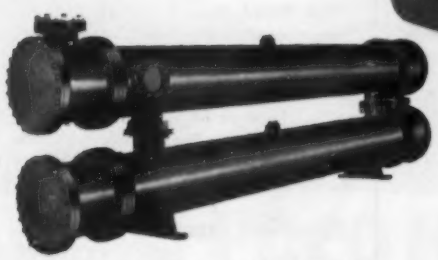
Each application is designed on the basis of more than a quarter century of experience in this specialized branch of power engineering. Installations are made by skilled mechanics.

THE ENGINEER CO.
75 WEST STREET, NEW YORK 6, N.Y.
In Canada: Rock Utilities Ltd., 80 Jean Talon St. W., Montreal, P. Q. EC-204

FOR LONG SERVICE
WITHOUT SERVICE

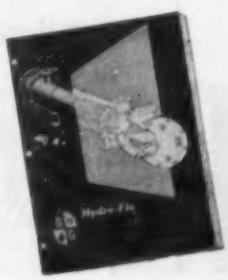
B&G
HEAT EXCHANGERS

Tank Suction Heaters • Oil Preheaters • Condensers • Evaporators • Aftercoolers • Gas Coolers Oil Coolers • Centrifugal Pumps Water Heaters



Two single pass, channel head B & G Heat Exchangers for series operation

B & G Heat Exchanger with U-bend tubing



For additional information on B & G Heat Exchangers send for Catalog DM-1150.

B & G shell and tube Heat Exchangers give you *more value per dollar because they are built that way!*

Basically efficient in design, these units are offered with straight and U-bend tubing. Ample material thicknesses in every detail and high tensile strength bolting are assurance of lasting strength and long operating life. Full tube bundles and close tolerances between shell wall and baffles prevent slippage of fluid and assure maximum heat transfer. Units can be furnished with tubing of copper, steel, several of the stainless steels and other non-ferrous alloys.

B & G Heat Exchangers are built to ASME Code U-69 requirements and can be certified by Hartford Steam Boiler and Inspection Service.

Whatever your heat exchange problems may be, remember that the B & G engineering staff is always available for consultation.

BELL & GOSSETT
COMPANY
Dept. EB-36, Morton Grove, Illinois
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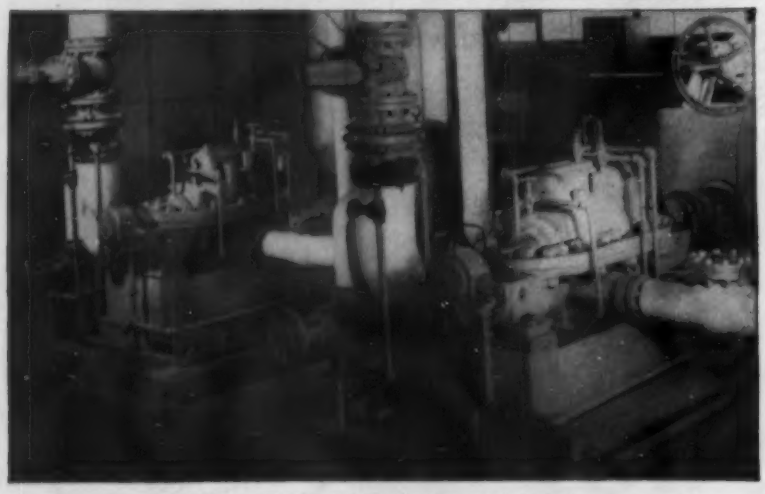
PRODUCTION CONTINUITY

Begins in the Boiler Plant



Warren Six Stage Boiler Feed Pumps installed at a Southern Board and Paper Mill.

Boiler Feed Pumps may look much alike, type for type, but it is well to keep in mind such intangible factors as:

- Experience and integrity of the manufacturer
- Dependability of product
- Know-how, Workmanship, Service
- Maintenance and Repairs
- Lost production due to down-time
- Early replacement because of "tight" original recommendations

It is impossible, of course, to get these items into your "specs," or the supplier into his "quotes," but don't overlook their importance with relation to price, possible future requirements and *production continuity*.

Get your share of "intangibles" . . . specify

WARREN QUIMBY PUMPS

P-31

WARREN PUMPS

WARREN STEAM PUMP COMPANY, INC.

Warren, Massachusetts

APPOINTMENTS

George L Abbott

Robert M Waples

Corporation executive changes

The Garlock Packing Co: George L Abbott, chairman of the board and chief executive officer; Robert M Waples, president; William M Sheffeld, vice-president. **Rockbestos Products Corp:** Albert S Redway, president. **Crouse-Hinds Co:** John R Tuttle, president and chairman of the board.

American Brake Shoe Co: George N Decker, first vice-president of Kellogg Division, William H Starbuck, vice-president of Sintermet Division; Fred L Cogswell, vice-president of Kellogg Division. **Borg-Warner Corp:** Howard J Davis, president of Calumet Steel and Franklin Steel Divisions.

C H Sprague & Son Co: DeWitt C Snyder, vice-president; W Ward Anderson, resident vice-president of Hampton Roads operations. **Hammel-Dahl Co:** John R Curran, vice-president. **Alan Wood Steel Co:** Perry L Francis, vice-president, marketing; William E Boger, vice-president, operations; Howard W Read, vice-president and comptroller. **The Louis Allis Co:** E P Allis, chairman of the board; John W Allis, president. **Sterling Electric Motors, Inc:** Edgar K Johnston, vice-president, manufacturing.

Operations executive changes

Climax Molybdenum Co: Elwin E Smith, manager, lubricant development. **Alan Wood Steel Co:** J Bremner Proctor, general manager of Penco Metal Products Division. **National - U.S. Radiator Corp:** Walter L Ross, manager of development laboratories. **Baltimore & Ohio Railroad:** Wilbur R Galloway, general manager, Eastern Region; C T Williams, general manager, Central Region. **Johns-Manville Corp:** Clinton B Burnett, general manager of Celite Division.

Engineer changes

Elliott Co: Max Schreiner, executive engineer. **Appalachian Coals, Inc:** H B Lammers, chief engineer. **Sterling Electric Motors, Inc:** John R Eastman, chief engineer. **Rockwell Manufacturing Co:** H E Rittenhouse, chief engineer of Pittsburgh Division. **Allis-Chalmers Manufacturing Co:** Charles L Babb, chief engineer of centrifugal pump dept; James C Barnett, plant en-

ONE GREASE ALONE

now handles practically every job in your plant

Improved POCO HT Grease is ideally suited for applications subject to extreme temperatures, moisture, speed and load.

Here's why:

- It has a higher melting point than most special "high temperature greases".
- It can be pumped at temperatures as low as −20° F.
- It lubricates completely under conditions of moisture and water.
- It has higher oxidation stability for longer life on the job.
- It provides extremely high protection against rust and corrosion.

Let your local Pure Oil representative tell you how improved POCO HT can cut lubrication costs for you. This may be the only grease you need in your entire plant. Why not call now and find out?

Now it's easier than ever to "Simplify and Save" With improved POCO HT headlining Pure's Multi-Purpose lubricants, you can now save more than ever with Pure's "Simplify and Save" Plan. Find out how it will work in your plant. Write for full literature. The Pure Oil Co., 35 E. Wacker Drive, Chicago 1, Ill.

PURE

Be *sure* with Pure

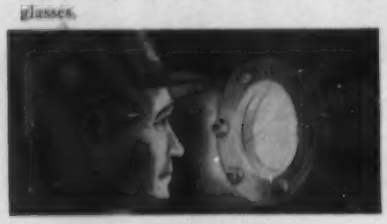
Sales offices located in more than 500 cities in Pure's marketing area.

PURE MULTI-PURPOSE LUBRICANTS

☑ *what* do you want to see?

☐ **WATER LEVEL?**

Pressures to 100 p.s.i.—CORNING brand STANDARD gauge glasses. To 300 p.s.i., and high temperatures—PYREX brand HIGH-PRESSURE gauge glasses. To 300 p.s.i., and corrosive conditions—PYREX brand HEAVY-WALL gauge glasses. For greater visibility—PYREX brand RED-LINE gauge glasses. 350 to 5000 p.s.i. (and higher in some cases)—MACBETH brand FLAT gauge glasses.



☐ **INTO HIGH-PRESSURE, HIGH-TEMPERATURE VESSELS?**

PYREX brand SIGHT GLASSES give you typical advantages of PYREX brand glass No. 7740—high thermal shock resistance, chemical stability, physical stamina, clear visibility, resistance to clouding.

☐ **LUBRICATION LEVELS, OIL LEVELS?**

PYREX brand lubrication and oil-cup glasses—long-lasting, chip-resistant, easy to install. Accurate dimensions insure a snug fit.

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Application	*Recommended Product*
Normal Conditions (Up to 100 p.s.i.)	CORNING brand standard gauge glasses
Higher temperatures	PYREX brand high-pressure gauge glasses
Higher pressures	PYREX brand heavy-wall gauge glasses
Extra visibility	PYREX brand red-line gauge glasses
Viewing inside furnaces, reactors pressure vessels, etc.	PYREX brand sight glasses
Lubrication inspection	PYREX brand lubricator glasses
Visible discharge devices	PYREX brand oil cup glasses

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Corning, New York

Corning means research in Glass

More APPOINTMENTS

Begins on page 238

gineer at Boston Works; N William Morelli, plant engineer at Terre Haute (Indiana) Works.

Recent mergers, purchases

Borg-Warner Corp: acquisition by merger of Byron Jackson Co, to become Byron Jackson Division of Borg-Warner Corp. **Walworth Co:** acquisition of assets through purchase of M & H Valve & Fittings Co and acquisition of Southwest Fabricating & Welding Co. **H K Porter Co, Inc:** purchase of Electric Service Engineering Co to be known as Esseco Division, H K Porter Co, Inc.

Obituaries

John H Collier, 70, former president, and chairman of the board of Crane Co, July 27, after a long illness.

Herbert J French, 62, vice-president of The International Nickel Co, Inc, and assistant vice-president of The International Nickel Co of Canada, Ltd, August 17, after an extended illness.

John C Mahoney, 77, superintendent of General Electric Co's turbine installation prior to his retirement in 1943, August 2.

More FREE LITERATURE

Begins on page 175

PUMPS

12 **Two-stage pumps** for boiler feed and other high-pressure applications. Closed-couple or frame-type construction, capacities to 300 gpm, heads 300 to 550 ft, temperatures to 250 F. Photos, cutaways, diagrams, charts in 6-p bulletin 52B6105C. Allis-Chalmers Mfg Co, 952 S 70th St, Milwaukee, Wis.

13 **Variable-volume pumps** are subject of two-page bulletin K-743-LP. Outlines features, includes capacity chart, photo. Seter Engineering Corp, 7626 W Florist Ave, Milwaukee, Wis.

14 **High-vacuum pumps.** Profusely illustrated 52-p catalog 425 includes cutaway drawings, diagrams, graphs, performance curves, installation photos, tabulations of data, conversion tables, charts and formulae. Units described range in size from a ¼-hp pump with displacement of 2 cfm to a 40-hp pump with displacement of 780 cfm. Kinney Manufacturing Division, The New York Air Brake Co, 3640 Washington St, Boston 30, Mass.

15 **Vertical turbine pumps** for industrial and municipal primary water supply are described in 8-page bulletin 100. Includes sectional illustrations, selection tables, detailed drawings of pumping and distribution systems, capacities. Layne & Bowler Pump Co, 2943 Vail Ave, Los Angeles 22, Calif.

16 **Pressure generators,** designed to produce hydrostatic pressures as much as 500 times greater than normal plant air supplies. Capacity pressure ranges, diagrams, applications in 4-p bulletin 755. Milton Roy Co, Station J, 1300 E Mermaid Lane, Philadelphia, Pa.

17 **Rotary gear pumps** for oils, burner service, lube oil circulation, general transfer in range of 32 to 250,000 ssu, 1 to 350 gpm, 300 psi for continuous duty, 500 psi for intermittent service. Applications, dimensions,

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Simplifies pipe layouts, prevents accidents, fits all valve wheels. Your supplier carries complete stocks. Call him — or write for folder and prices.

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Each pipe hanger is scale tested to rigid tolerances by a skilled workman at the Navco plant. After final assembly and inspection, the hangers are carefully crated and readied for shipment.

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"JOHN CRANE" FreeFlow Construction
Gasket flush with pipe I.D.—allows completely unrestricted flow.
No air pocket—insert flush with I.D. of envelope. No danger of rupture due to expansion of entrapped air at high temperatures.
AIR
Ordinary "Wishbone" Construction
Envelope extends beyond I. D. of pipe, causing flow restriction and turbulence.
Expansion of entrapped air at high temperatures presents danger of gasket rupture.

FOR EVERY CORROSIVE SERVICE

"John Crane's" FreeFlow construction and chemically inert Teflon have been combined as *the* answer for gaskets in corrosive service. This new construction assures a flush fitting with the I.D. of the pipe and the inner wall of the Teflon envelope, not possible with the ordinary "wishbone" type gasket. (See drawing above).

This means elimination of:

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"John Crane" Teflon FreeFlow gaskets are impervious to practically every known chemical or gas and are unaffected by temperatures from −100° to +482°F., depending on the insert material. They are available in all shapes and sizes for a wide variety of applications, such as glass lined, porcelain, pyrex and similar equipment, including reactor kettles and pipes, distillation columns and nozzles.

Request full information on "John Crane" FreeFlow gaskets for your particular requirement. Ask for our informative booklet, *The Best in Teflon*, for other important technical and application data. Crane Packing Company, 1830 Cuyler Avenue, Chicago 13, Illinois. *In Canada: Crane Packing Co., Ltd., 617 Parkdale Ave., N., Hamilton, Ont.*

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JOHN CRANE CRANE PACKING COMPANY 38 YEARS INDUSTRIAL PROGRESS

More FREE LITERATURE

Begins on page 175

capacities in 8-p bulletin. Sier-Bath Gear & Pump Co, Inc, 9252 Hudson Blvd, North Bergen, N. J.

METALS AND ALLOYS

18 **Nickel austenitic** ductile irons is subject of 4-p paper that compares properties of conventional and ductile Ni-Resist irons. Summarizes present and potential industrial applications. The International Nickel Co, Inc, 67 Wall St, New York 5, N. Y.

19 **Vacuum-melted metals** and alloys are discussed in 23-p bulletin VM-101. Covers effects of vacuum melting on properties of various metallic materials, benefits of the process to the user of such metals and fabricating and machining recommendations. Carboloy Department, General Electric Co, Detroit 32, Mich.

20 **Aluminum alloys.** Illustrated 6-p bulletin details general properties, fabricating characteristics, applications, available size ranges of each alloy. Includes weight comparison and temper designation charts. Peter A Frasse & Co, Inc, 17 Grand St, New York 13, N. Y.

WATER TREATMENT

21 **Instrument control** for water-treatment plants is described in 12-p bulletin 90-241-10. A two-page flow sheet graphically illustrates most of instrument applications possible in a large municipal system. Fischer & Porter Co, Hatboro 35, Pa.

22 **Traveling water screens** for use in power stations and water-treatment plants are described in illustrated 4-p bulletin 885. Sanitation Sales Division, The Jeffrey Manufacturing Co, Columbus 16, Ohio.

23 **Chemical treatment** of industrial cooling water is subject of 4-p bulletin. Includes a discussion of the nature and causes of troubles that attend the use of cooling water. Western Chemical Co, 713 Washington St, Kansas City 5, Mo.

24 **Control of pH** and redox in industrial waste-treatment processes is discussed in 4-p illustrated bulletin 700(2). Leeds & Northrup Co, 4934 Stenton Ave, Philadelphia 44, Pa.

WELDING

25 **Welding equipment,** manual and automatic units along with accessory apparatus and welding wire, is detailed in illustrated 16-p bulletin 2350. Air Reduction Sales Co, a division of Air Reduction Co, Inc, 60 E 42nd St, New York 17, N. Y.

26 **Nickel-base alloys** furnished in powdered form and used for hardsurfacing and brazing are discussed in 4-p illustrated bulletin. Coast Metals, Inc, Little Ferry, N. J.

MISCELLANEOUS

27 **Nuclear research reactors.** Illustrated 8-p bulletin GEA-6326 lists and pictures various reactors and components that can be used in industry, education and research. Apparatus Sales Division, General Electric Co, Schenectady 5, N. Y.

28 **Lightning arresters** and fuse cutouts are subject of 20-p bulletin. Covers design, application and performance of *Autogap* arrester. Fully illustrated. Hubbard and Co, 6301 Butler St, Pittsburgh 1, Pa.

29 **Overhead cranes.** Traveling bucket-type units are subject of a "right and wrong" performance discussion in 8-p illustrated bulletin 2510. Blaw-Knox Co, Box 1198, Pittsburgh 30, Pa.

30 **Pipeline protection.** Illustrated 16-p bulletin describes various pipe-wrap tapes, electrical tapes, pipe primers and products designed to prevent corrosion. Minnesota Mining and Manufacturing Co, St Paul 6, Minn.

For liquid-handling economy

select the right pump for the job

Goulds pumps are designed for easy maintenance and built so they need a minimum of it.

These seven groups of pumps are only a few of the many models made by Goulds—yet in these groups are pumps for hundreds of industrial liquid-handling jobs—242 combinations of pump models, sizes and materials.

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Many other unique features mean fewer maintenance worries for you, longer service life. Support heads have a cooling chamber preventing transfer of heat to bearings. Shaft sleeves are shouldered on the shaft near the impeller. They expand and contract freely with temperature changes. Sealed housings keep dirt and moisture out of the ball bearings.

Specify Goulds pumps and take advantage of their cost-saving features. Your Goulds representative will help you select the pumps best suited to your needs. Consult him on your liquid-handling problems, or write direct to Goulds Pumps, Inc., Seneca Falls, N. Y.

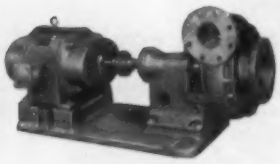

Fig. 3755 single-stage, enclosed impeller pump, available in 21 sizes providing capacities up to 3,800 GPM, heads to 400 ft. Extra-heavy construction throughout, for trouble-free service 24 hours a day, over long periods. Send for Bulletin 715.1 for specifications, performance curves.

Fig. 3715 single-stage, chemical pump for handling corrosive and abrasive liquids. 9 sizes provide capacities up to 720 GPM, heads to 200 ft. Available in Types 316 and Gould-A-Loy stainless steel, all-bronze, all-iron, bronze-fitted, or iron or bronze with stainless trim. Ask for Bulletin 725.4.

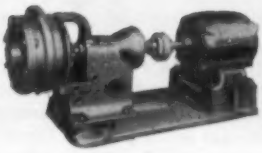

Fig. 3345 two-stage pumps in 5 sizes provide heads up to 500 ft., and capacities to 120 GPM. Impellers mounted back-to-back neutralize end thrust. Impeller clearance easily adjusted by external means. Write for Bulletin 718.2.

Fig. 3320 "close-cupld" two-stage pump, in 5 sizes, provides heads to 500 ft., capacities to 120 GPM. Impellers mounted back-to-back, directly on extended motor shaft. Permanent alignment assured by recessed lock fit on adapter. Ask for Bulletin 713.1.

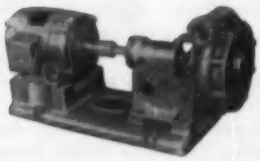

Fig. 3770 single-stage, enclosed impeller pump, with belt or motor drive. 14 sizes with capacities ranging from 10 to 1,800 GPM, and heads to 120 ft. Ideal for clear liquid applications. Available in all-iron, all-bronze or bronze-fitted construction. Write for Bulletin 622-A2.

Fig. 3189 single-stage, open impeller pumps, with belt or motor drive. 10 sizes provide capacities up to 1,080 GPM, heads to 180 ft. Especially built for handling slurries, other solids—containing liquids. For specifications, performance curves, write for Bulletin 720.4.

Fig. 3650 single-stage "close-cupld" pump, for motor or turbine drive. 20 sizes offer capacities to 2,000 GPM, heads to 400 ft. All units are self-contained, need no special foundation. Open-top construction gives ready access to gland and stuffing box. Available in all-iron, all-bronze, or bronze-fitted construction. Send for Bulletin 710.1 to get specifications, performance curves, other details.

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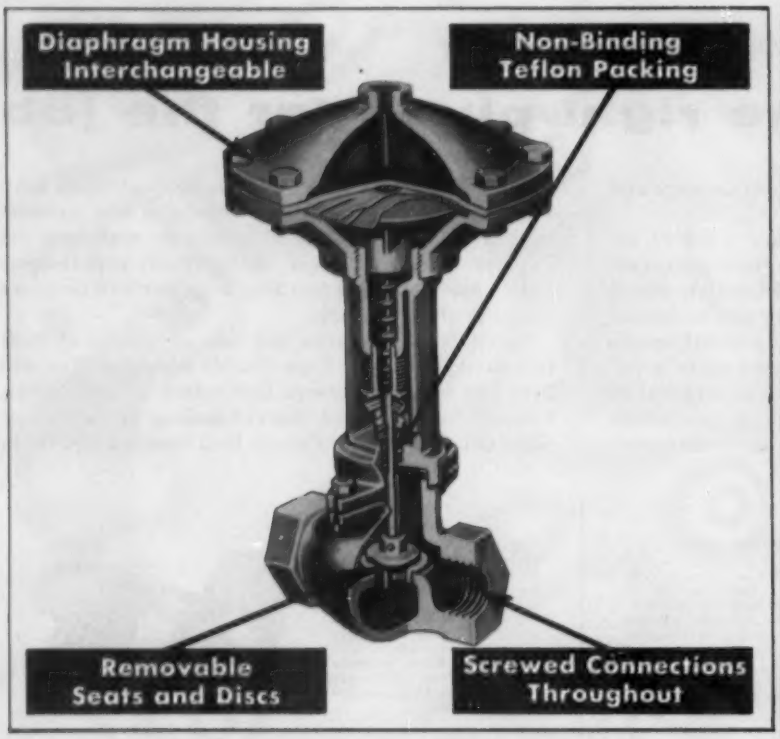


New direct operated reducing valve provides control to one pound downstream pressure

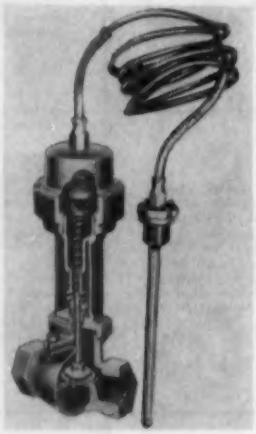
The new Squires Class HS direct operated valve opens new fields of control accuracy in any medium. Operating from 250 psig. to vacuum, this spring loaded Squires valve can reduce initial pressure to a downstream pressure accuracy of plus or minus 1½ pounds.

Complete application flexibility is provided with these valves because component parts are interchangeable. Diaphragm housing assembly with compensating spring is interchangeable to meet different pressure requirements. Reduced size seats and discs can be used for lower capacity requirements.

The companion Squires Class HT temperature regulating valve uses the same basic construction as the Class HS valve. Models are available to regulate temperatures in the 40°, 60° and 100° F. ranges. With simple modifications, either valve can be made to handle the job of the other.

Standard construction is bronze—steel can be provided when needed. Screwed connections are used throughout. Teflon packing assures completely free stem movement, positive valve seal, and low maintenance. Removable stainless steel seats and discs. Class HS models are available in sizes from ¼ to 1½ inch . . . Class HT from ¼ to 1 inch.

For further information call your local Squires representative or write to: The C. B. Squires Co., 18502 Syracuse Ave., Cleveland 10, Ohio.



Class HT temperature regulating valve has same body and close sensing features of Class HS spring loaded pressure reducing valve.

S-104

SQUIRES

More TECHNICAL BRIEFS

Begins on page 162

and separate development of thermal and hydrodynamic boundary layers were investigated. The Reynolds modulus ranged from 76 to 1756; Graetz modulus, from 9.5 to 170,000. Investigation of 24 ratios of L/C from 0.782 to 148 was possible with the equipment.

The data have been correlated with an adaption of the Hausen approximation to the Graetz second solution for tubes with calming sections. An attempt has been made to explain deviations caused by free convection and changes in velocity distribution due to change of temperature by the use of a Grashof group. The "viscosity-increased" water produced results that were from 0.2 to 0.5 of the theoretical value. *ASME paper No. 55-SA-17.*

Electrical equipment

Design of optimum clearances in positive displacement pumps and motors. *By Professor Warren E Wilson, The Pennsylvania State University.*

Since efficiency of a positive-displacement pump or motor depends, to a great extent, upon slip flow and drag developed by moving surfaces, it is essential to proportion slip passages in such a manner that energy losses are kept to a minimum. In this presentation, slip flow and drag on the moving elements are determined on basis of a theory of laminar flow. This takes into consideration internal heating of the liquid and consequent reduction in viscosity. Optimum clearance, under various operating conditions is determined. It is shown that under certain circumstances, optimum clearance is not materially different from that predicted by the constant-viscosity theory. Under other circumstances, minimum clearance that is physically possible is shown to be the optimum. *ASME paper No. 55-S-4.*

A hydraulic manual power closing mechanism for power circuit breakers. *By E R Perry and N W Morelli, Allis-Chalmers Manufacturing Co.*

A new portable device for safe, manual closing of power circuit breakers has recently been designed, tested and put into production. It utilizes the basic principle proven practical in the *Pneu-Draulic* operating mechanism for high-capacity power circuit breakers.

Designated the *Manual Power Closing Device*, this unit is not meant to replace the standard electrical operator normally used with oilless air and small

(*Continued on page* 248)

Directions for ordering papers on p 256

Specify "TUBE-TURN" and you know you're right

THIS TUBE-TURN* Welding Return has a bursting strength at least equal to that calculated for the seamless pipe with which it is recommended for use. Made in U.S.A., it meets all American Standard and Safety Code requirements. Welders everywhere know it will line up perfectly . . . because it's forged by the only process that produces a wall with the maximum uniformity of thickness and circularity. In short, when you specify "TUBE-TURN" you *know* you're right.

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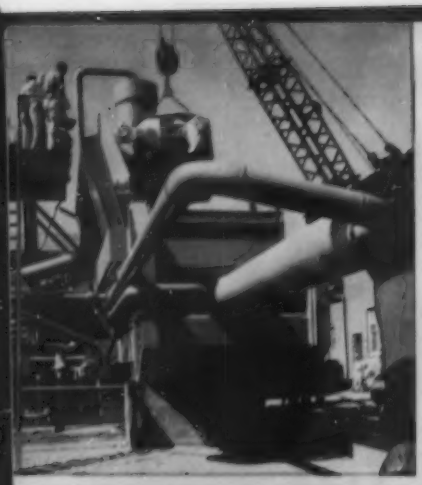

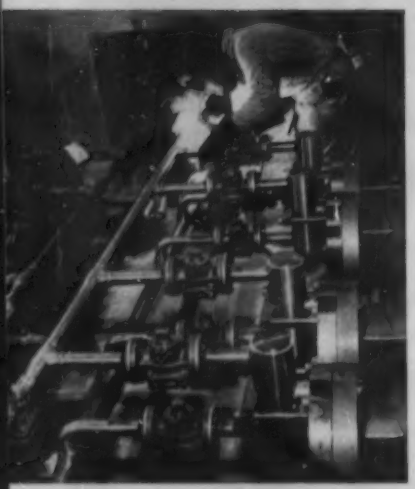

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This unique press squeezes old automobiles into bales of metal to expedite scrap recovery. Designers of the press called on Tube Turns' Engineering Service for assistance in laying out the piping for the hydraulic system. Result—efficient, leakproof piping that enables the press to do its job on a two-minute cycle. Tube Turns' unmatched piping experience can help *you* when you have an out-of-the ordinary piping problem.

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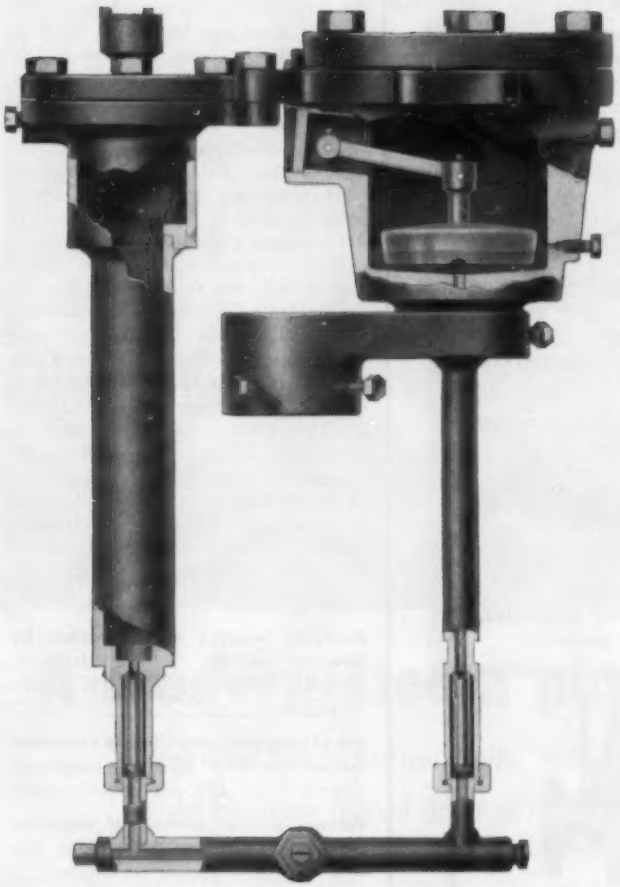


Taylor Mercury Flow Meter keeps a 24-hour watch on loss of steam or water

DOES your plant have a high loss of fluid that is usually written off as unavoidable "hidden cost?" Often the loss of fluids, (steam, water or compressed air) is not considered costly or serious until it has been measured. But the cost over even a short period of time can be enormous. An accurate Taylor flow meter installed on the utility lines to a department or building will detect abnormal consumption of steam, water or compressed air which might be caused by faulty traps, sticky valves or carelessness.

For measuring flow the Taylor Instrument Companies manufacture the highly accurate Mercury Manometer and Aneroid (non-mercury) Manometer.

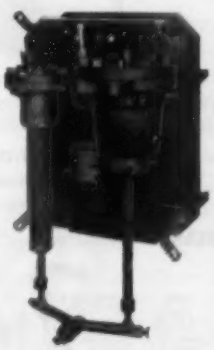
NOTE THESE DESIGN FEATURES:

GREAT POWER—thanks to extra big float with extra long travel. Microfinished shaft with Teflon bearings "float" this power right through to the pen.

HIGH ACCURACY—straight-line calibration is built into the instrument.

POSITIVE ACTUATION—high energy output due to big float (3 5/16"), long travel (1"), and simple lever system. Jewelled thrust bearing and Teflon in pressure-tight bearing surfaces use the power efficiently.

DEPENDABLE PERFORMANCE—submerged check valves give positive shut-off. Unique damping valve is adjustable under full pressure without leaking. There is ample room in the mercury chambers to accommodate surges or pulsating flows. Teflon in the bearing surfaces holds pressure, but lets shaft turn freely, giving long service.



EASE OF MAINTENANCE—easy access to float and lever arm during calibration through the low pressure chamber cover. Entire pressure-tight bearing easily, economically replaced.

MIXING—Two manometers can be mounted back to back on one case, to measure two flows, or control ratio-flow.

ASK YOUR Taylor Field Engineer, or write for **Bulletin 98175.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

FLEXIBILITY—Piping changes are not necessary in changing from one range to another, because there are six interchangeable range tubes (10", 20", 50", 100", 200", and 400" of water). All but the 10" range can be over ranged or under ranged by 33⅓%. Pressure connections are at both side and top of the manometer. A union coupling prevents distortion of bearing housing, and eliminates binding or friction caused by wrench torque.

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ACCURACY FIRST
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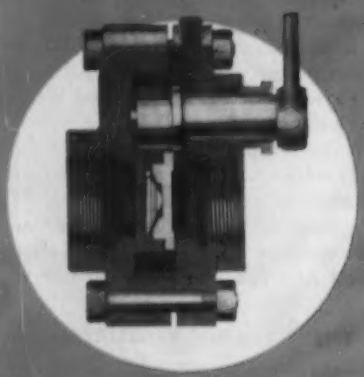

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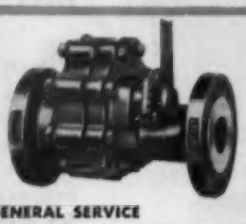

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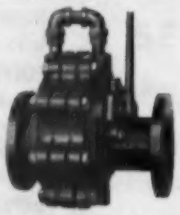

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For automatic drains or emergency shut off.

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More TECHNICAL BRIEFS

Begins on page 162

outdoor oil breakers. Its purpose is to supplement the operator, to supply an external source of closing power for safe, full speed, manual closing of the breaker onto an energized line when control power has been lost.

The closing force provided by the device is applied to the breaker contacts through the mechanically trip-free toggle linkage, that is a standard part of the operating mechanism of the circuit breaker. This feature insures immediate opening of the breaker contacts if an attempt is made to close the breaker onto a faulted line.

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Other papers of timely interest:

Analyzer features made possible by zero-loss reactors. *By E W Atherton, I-T-E Circuit Breaker Co. APC paper; no number.*

Use of magnetic amplifiers in excitation control. *By T J Bliss, Westinghouse Electric Corp. APC paper; no number.*

Voltage divider method of capacitor switching. *By Harold Stone, Line Material Co. APC paper; no number.*

Industrial power distribution—bus duct or load centers. *By Harry Decker, Electro-Motive Div, General Motors Corp. APC paper; no number.*

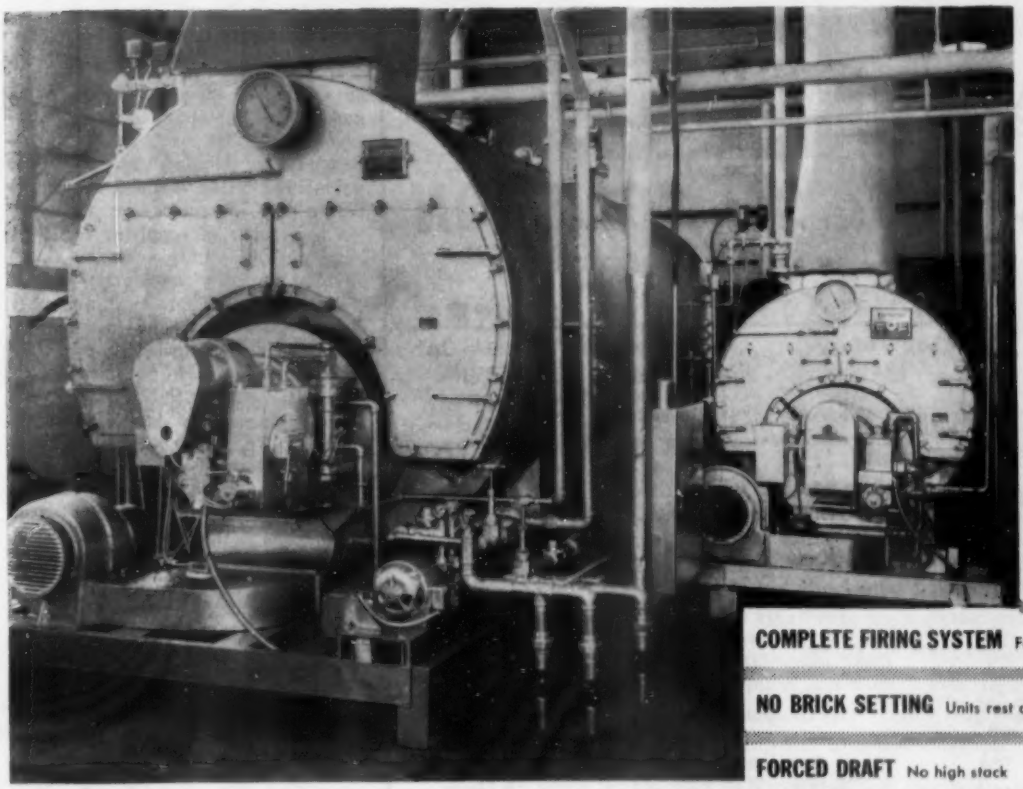
Planning systems for long-range growth. *By H L Melvin, Ebasco Services Inc. APC paper; no number.*

Water treatment

Demineralized make-up for 1250-psi installation at East Millinocket Mill of Great Northern Paper Co. *By E F Davidson, Stone & Webster Engineering Corp.*

In 1952, the Great Northern Paper Co planned an increase in manufacturing capacity at its East Millinocket, Maine mill from 325 to 900 tons per day of newsprint, necessitating an enlargement of its steam-generating plant. Results of studies showed that new boilers

Directions for ordering papers on page 256



Boiler room, Bendix-Skinner Division of Bendix Aviation, Detroit. Iron Fireman firing equipment installed by Comb & Groves. Giffels & Vallet, Inc., Consulting Engineers.

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More TECHNICAL BRIEFS

Begins on page 162

should supply 1250-psi 850-F steam to noncondensing extraction turbine-generators, and that maximum byproduct power should be generated to the limitation imposed by steam flow through the turbines, as required for process.

The problem of supplying relatively large quantities of feedwater makeup of suitable quality was a major consideration. Shortly before 1952, a number of high-capacity water-treatment installations of the demineralizer type had been installed. These provided operational background for justifying the 1250-psi steam plant from this standpoint. *ASME paper No. 55-SA-75.*

Other papers of timely interest:

Filming amines — use and misuse in power-plant water-steam cycles. *By J F Wilkes, Dearborn Chemical Co, Dr W L Denman, Dearborn Chemical Co, and Dr M F Obrecht, Michigan State College. APC paper; no number.*

Treatment of makeup water with a four-bed demineralizing plant. *By W M Mayer, Central Power & Light Co, Corpus Christi, Texas. APC paper; no number.*

Handling and disposal of radioactive wastes. *By J A Lieberman, U.S. Atomic Energy Commission. ASCE paper; no number.*

Demineralization of makeup for public utility plants. *By J A Wallace and L W White, Iowa Electric Light and Power Co., Cedar Rapids, Iowa. APC paper; no number.*

Treatment of makeup water with automatic mixed-bed demineralizer. *By B F Borgel, Pennsylvania Electric Co, J H Brendlen, Gilbert Associates, Inc, and V J Calise, Graver Water Conditioning Co. APC paper; no number.*

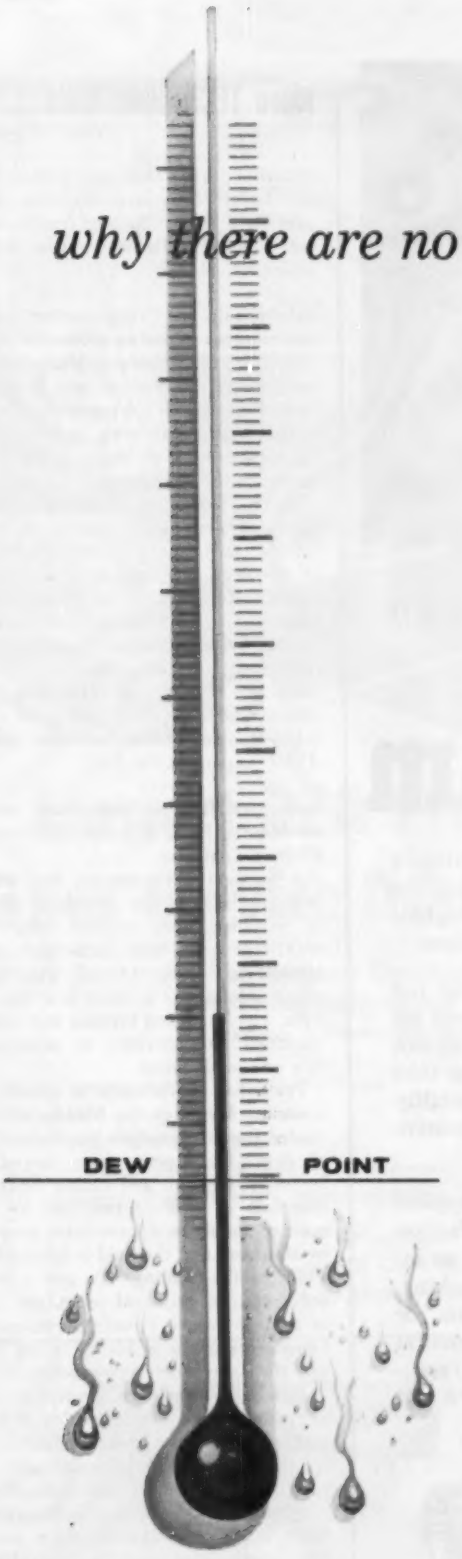
Conversion of saline water. *By D S Jenkins, Dept of the Interior, Washington, D.C. APC paper; no number.*

Turbo- and hydrodynamic machinery

Hydraulic-turbine design problems. *By John Parmakian, United States Bureau of Reclamation.*

This paper describes several serious deficiencies that were observed at various hydraulic-turbine installations. It includes an account of causes leading to failure of bolted bucket-type runners for impulse turbines, excessive distortion of a large-diameter stay ring for a Francis turbine, objectionable vibration

Directions for ordering papers on page 256



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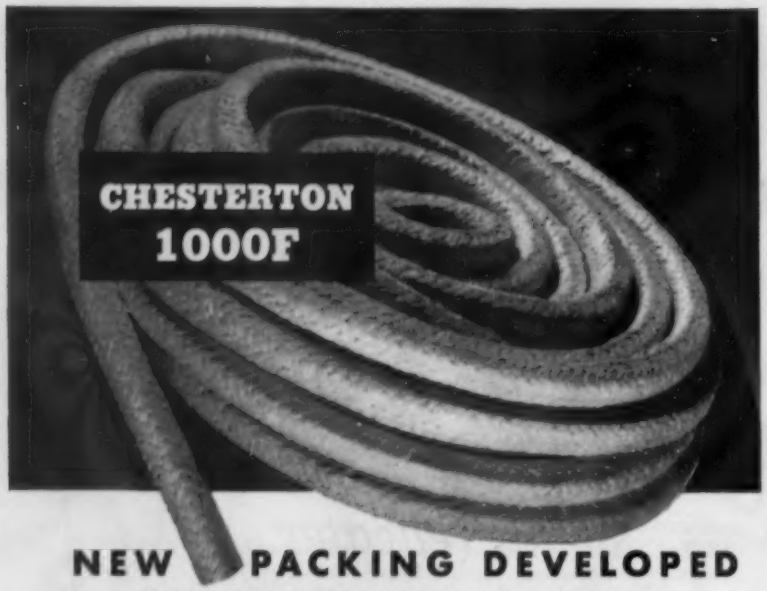

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More TECHNICAL BRIEFS

Begins on page 162

of turbine shafts at several installations, and failure of a large-diameter spiral case for a Francis turbine due to excessive bending in the stay vanes. *ASME paper No. 54-A-68.*

Relationship of regenerative pump performance to casing geometry. *By W A Wilson, M A Santalo, Massachusetts Institute of Technology, and J A Oelrich, Worthington Corporation.*

This paper deals with an experimental investigation of effect of regenerative-pump casing geometry on performance characteristics of the pump. Results are presented in terms of parameters consistent with the hypothesis of operation presented in a companion paper. Relationship of these parameters to the prior art of hydrodynamic machinery and to those geometric features peculiar to regenerative pumps is developed. Cognizance is taken of inlet and exit phenomena as well as of characteristic mechanism of the pump. *ASME paper No. 54-A-60.*

Secondary flow in axial-flow turbomachinery. *By L H Smith, Jr, General Electric Company.*

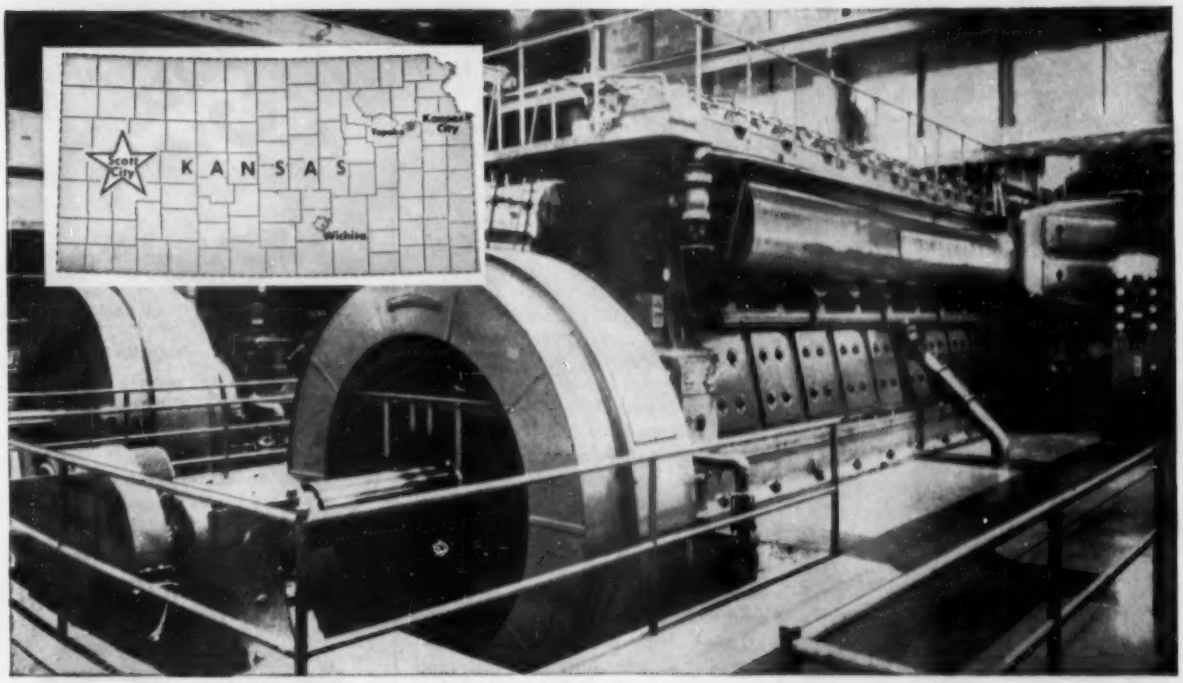
A method is presented by which one can include the principal effects of secondary flow in the design of multistage axial-flow turbomachinery. Method uses conventional axial-symmetry solution as a basic flow picture from which induced turning and radial velocities characteristic to secondary flow can be deduced.

Frictional effects, such as growth of boundary layers on the blades, are excluded from the analysis but disposition of fluid, that comes from boundary layers on the hub and casing surfaces upstream of a blade row, can be accounted for in an approximate manner by assuming that the fluid is frictionless while in the blading. To get a first-order approximation of secondary flow in a blade row, it is only necessary to know the number of blades in the row and the axisymmetric-flow solution.

Principal assumption involved in this approximation is that distortion of flow surfaces due to secondary velocities is small. The method is sufficiently accurate for predicting secondary flows that occur as a result of nonuniform blade loading, but solutions for boundary-layer flows must be considered only qualitative because of large flow-surface distortions that are associated with these flows. *ASME paper No. 54-A-158.*

(*Continued on page* 254)

Directions for ordering papers on page 256



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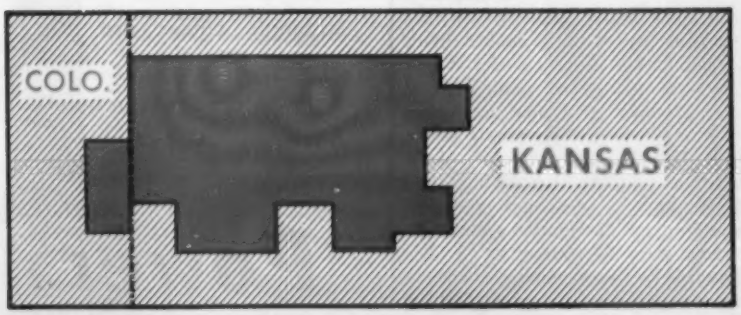

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Begins on page 162

Turbine-generators

Proposed guide for maintenance of turbine generators. *By J W Jones, Philadelphia Electric Co.*

This paper is essentially a compilation of material obtained from manufacturers' instruction books and AIEE publications. It is a proposed section on maintenance for a guide being prepared by the AIEE Committee on Rotating Machinery, Synchronous Machinery Subcommittee.

Specific items covered include collector rings and brushes, air filters, gas or air coolers, hydrogen leak detection, armature windings, rotor, terminal bushings, fans, hydrogen seals, seal-oil and vacuum pumps, bearings, gas control, cleaning and painting, moisture protection, testing, and others. *AIEE paper No. 55-122.*

Operation of turbine generators during off-peak high power-factor periods—practices of one utility in a metropolitan area. *By W J Roberts and R L Webb, Consolidated Edison Co of N. Y.*

Before World War II, the Con Ed 60-cps system operated with the load distributed mainly from the generating-station buses with relatively low-capacity intermediate-voltage tie feeders interconnecting major stations from north to south. Largest of several interstation ties was rated about 40 mva. Some operated at 13 kv, some at 27 kv.

Load power factors at that time, measured at station bus, varied from 0.83 to 0.85 during day loads and dropped to 0.78 to 0.80 during early morning off-peak loads. Generator terminal power factors varied from 0.80 minimum during the day to 0.75 during off-peak operation. Capacitive loading consisted of the 13- and 27-kv distribution feeder cables, plus a small amount of 4-kv distribution feeder capacitors.

Since the start of World War II, the 60-cps system experienced a 61% peak-load increase with a corresponding 65% rise in generating capacity and has been equipped with a double-circuit high-voltage (138-kv) tie-feeder system between the north and south ends of the area served. One new generating station has been built to supply power directly into this feeder network. Area substations supplied from the high-voltage circuits have been built to supply medium-voltage distribution systems direct from the 138-kv circuits.

New 138-kv system circuits are made up of pressure-pipe type and oil-filled cable feeders. These, including older 138-kv cables, have added a total of

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FIG. 22—Standard

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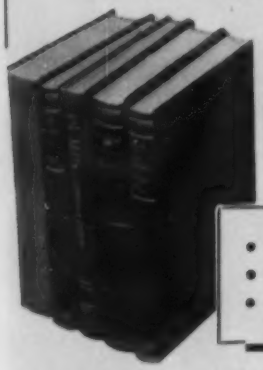

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More TECHNICAL BRIEFS

Begins on page 162

about 295 capacitive megavars to system load at normal voltage. Installation of unswitched capacitors on the 4-kv part of the system have added an additional 85 megavars.

This increase in capacitive load has been helpful in assisting to supply the load and system equipment demand for reactive megavars during the day high-load periods but early morning light-load power factor has risen to about 0.97 lagging. As system develops it is anticipated the early morning load power factor will soon be slightly leading. *AIEE paper No. 55-120.*

Other papers of timely interest:

Research and development in the field of turbine-generator prime movers in the General Electric Co. *By Glenn B Warren, General Electric Co. APC paper; no number.*

Advances in large steam-turbine research and development. *By H D Emmert, Allis-Chalmers Manufacturing Co. APC paper; no number.*

The development laboratory as an engineering tool in research and development in the field of steam turbines and auxiliaries. *By F K Fischer, Westinghouse Electric Corp. APC paper; no number.*

TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from source, not POWER.

American Society of Mechanical Engineers. Identified by initials ASME and obtainable through ASME, 29 W 39th St, New York 18, New York.

American Institute of Electrical Engineers. Identified by initials AIEE and obtainable through AIEE, 33 W 39th St, New York 18, New York.

American Power Conference, 17th annual meeting. Identified by initials APC and obtainable through purchase from R A Budenholzer, chairman, Illinois Institute of Technology.

American Society of Civil Engineers. Identified by initials ASCE and obtainable through ASCE, 29 W 39th St, New York 18, New York.

Third annual convention of the North Carolina Hospital Engineers Assn was successfully held on August 11 to 13. Despite hurricane "Connie" attendance was good.

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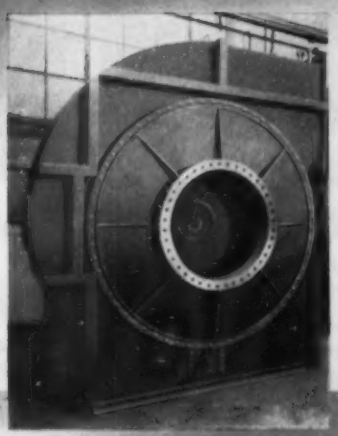

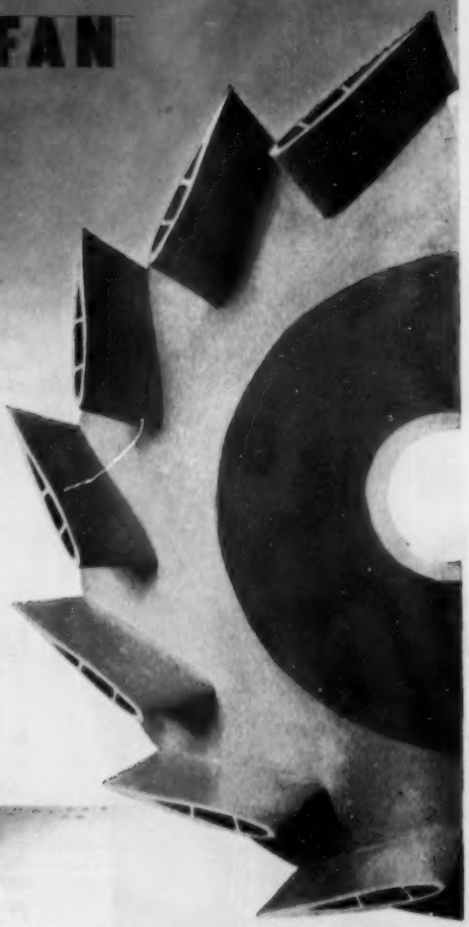

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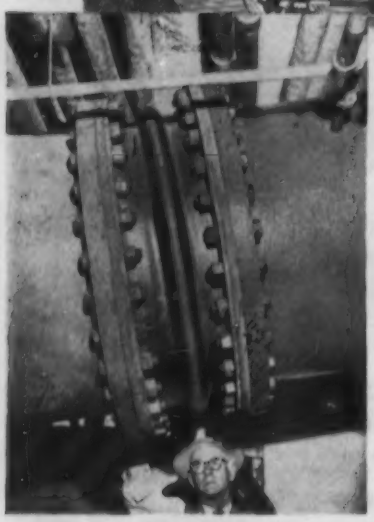


Note great size of this U. S. Expansion Joint installed on a generator in the New Orleans S&WB plant at Eagle and Spruce Streets

for over 26 years U. S. Rubber Expansion Joints have been doing just that!

New Orleans is a city nestled in a saucer. Surrounded on all sides by water, many of its areas are below sea level. Add to this, one of the heaviest rainfalls in the country (as much as 15 inches in 17 hours) and you can see that this glamour city could easily be flooded.

But the New Orleans S&WB* keeps the city's feet dry by means of a pumping system that carries off the rain. Turbo-generators supply the power not only to operate this drainage pumping system but also the separate sewage pumping and the water supply systems.

26 years ago, one of these turbo-generators *(in use 98% of the time)* was equipped with 5 United States Rubber Company Expansion Joints. Why? To allow for contraction and expansion in pipe lines, and to counteract vibration. Says the Chief engineer of the S&WB: *"The U. S. Joints have never failed in all that time.* If any of them ever had, the turbine would be out of use."

U. S. Expansion Joints are widely used in the pipe lines of utility generating plants, municipal water supply systems, office and apartment buildings, ships – wherever pipe lines have to be protected against vibration, contraction and expansion. These joints soon pay for themselves by eliminating expensive maintenance and replacement in pipe lines. They eliminate noise. Once installed, you can count on years of trouble-free service. Obtainable at any of the 27 "U. S." District Sales Offices, or write address below.

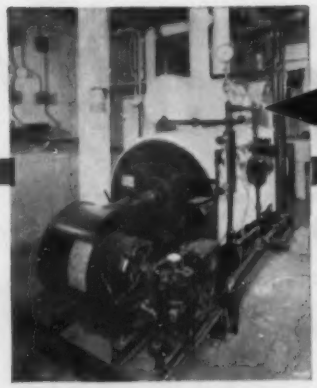
*Sewerage and Water Board

"U. S." Research perfects it..."U. S." Production builds it...U. S. Industry depends on it.

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting



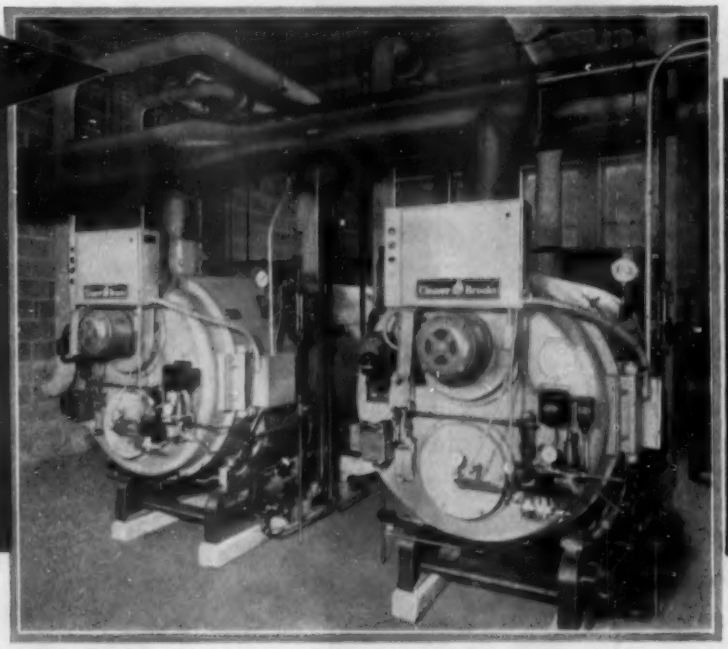
1931

Cleaver-Brooks pioneers big steam capacity in small space

This veteran 20-hp heating boiler — built by Cleaver-Brooks and installed in 1931 — is still in daily use. It is proof of the dependable service you can expect from Cleaver-Brooks' famed four-pass, self-contained boiler construction for any heating or processing need.

1955

Cleaver-Brooks is first again with the ALL NEW "CB" Boiler



- All main burner components are completely integrated for automatic operation.
- More boiler capacity in less space through elimination of extended burner assembly platform.
- Guaranteed 80% efficiency — Four pass construction. 5 sq. ft. of heating surface per bhp.
- 11 sizes — 79 models — 15 to 150 hp, (steam or hot water) for oil, gas or combination oil/gas use. Other models available through 600 hp.
- Complete (Boiler-Burner) unit approval by Underwriters Laboratories — conforms to ASME codes. Factory tested before shipment.

The "CB" is the most easily maintained package boiler on the market. Removal of only nine bolts (on the largest sizes) opens hinged doors for fast inspection, cleaning or service. This convenience has earned widespread praise of insurance firms.

BOILER users will quickly appreciate the surprisingly silent operation of the new forced-draft "CB" — *with the fan mounted inside the front hinged door.* Design avoids use of thin sheet metal housings and usual "chattering" and vibration.

Even greater combustion efficiency is yours with the new "CB" air-atomizing burner, with integral air compressor. All burner components are confined to the front head and the control panel is at operator eye level.

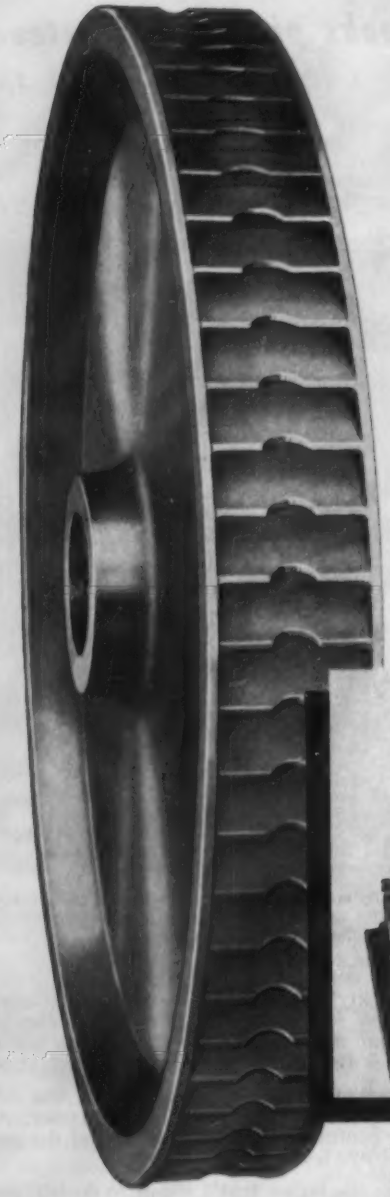
For complete facts on the boiler that's ahead in design, performance and economy, write: Cleaver-Brooks Company, Dept. L, 301 E. Keefe Ave., Milwaukee 12, Wis., U.S.A. Cable Address: CLEBRO — Milwaukee — All Codes.

Write for copy of latest "CB" Boiler Bulletin covering your size requirements — contains specification data to help you plan.

Cleaver Brooks

Originators of the self-contained boiler

TERRY SOLID-WHEEL *SIMPLICITY* MEANS *SUSTAINED* HP



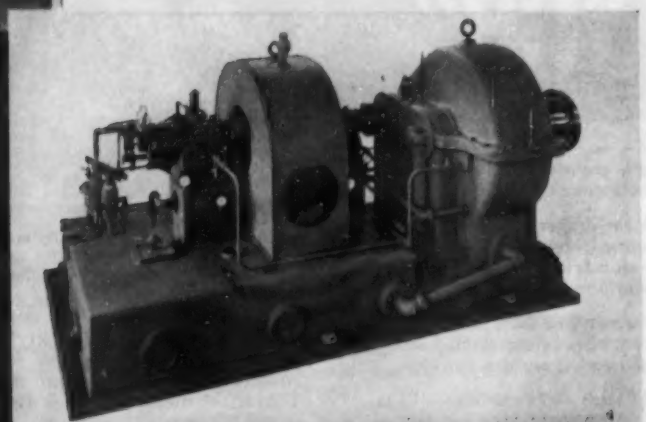
A Terry solid-wheel turbine is simplicity itself. Particularly the rotor. This is a single forging of special composition steel. And, unlike a built-up wheel, has no separate parts to loosen or work out.

Blade wear which might occur after years and years of usage is of little consequence, because the power-producing action of the steam takes place on the curved surfaces at the backs of the buckets. Thus wear does not materially affect horsepower or efficiency.

The blades can't foul. There is a one inch clearance on either side of the wheel and, in addition, the blades are double rim protected. There is no need for close axial blade clearance, because the steam enters the buckets at right angles to the shaft.

Perhaps you, too, can profit from Terry solid-wheel stamina. Bulletin S-116 gives complete details. Send for a copy today.

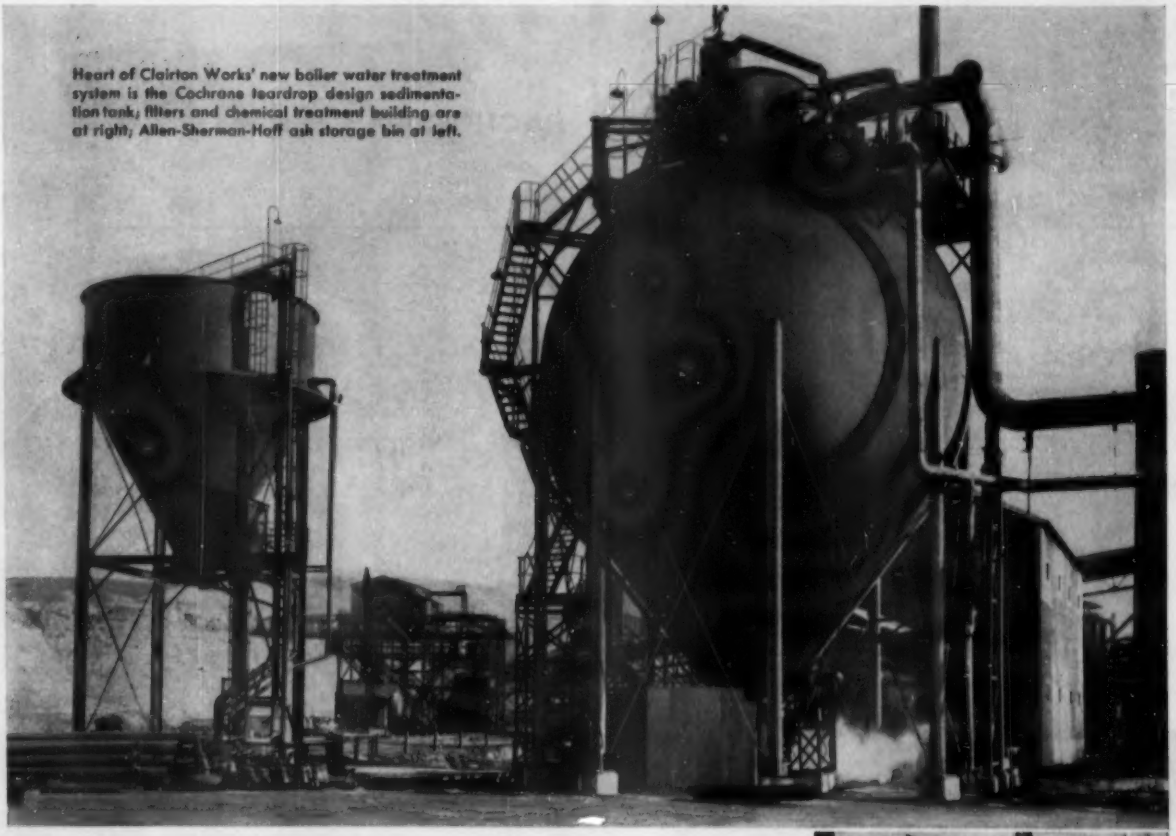
TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONNECTICUT



This Terry solid-wheel turbo-geared unit is rated 600 hp, 4000/650 rpm for 820 psi, 825°F steam with 275 psi back pressure.

TERRY

TT-1201



Heart of Clairton Works' new boiler water treatment system is the Cochrane teardrop design sedimentation tank; filters and chemical treatment building are at right; Allen-Sherman-Hoff ash storage bin at left.

How U. S. Steel solved a construction-production problem at Clairton

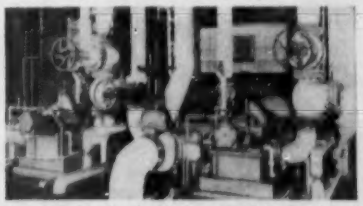
For several years engineers at U. S. Steel Corporation's Clairton Works searched for ways to meet increased steam demands at their coke oven and benzol plants. Existing boilers were being pushed to capacity and production requirements were mounting so rapidly that the only logical solution was new boiler facilities . . . but such a project presented several formidable problems as production would have to be maintained during construction, and the expansion had to be confined to a limited area to allow future expansion.

Solution to this problem is a good example of how Dravo's "complete package" construction service can work for you. After identifying their requirements and setting-up the necessary engineering specifications U. S. Steel engineers contacted Dravo for some preliminary estimates and construction ideas. What they received was a complete, coordinated plan for the whole program that relieved them of the multitude of planning details and permitted their dealing with one prime source of responsibility for the entire project.

Result was construction by Dravo of an expandable boiler plant and water treatment system to their requirements and without a day's loss of production time. The new plant is capable of supplying 200,000 lbs. of 600 degree steam per hour at 250 pounds pressure and treating 100,000 gallons of water per hour with a deaerating capacity of 80,000 lbs. per hour.

You, too, can profit through Dravo's single-contract responsibility, ranging over all types of jobs from boiler plant construction to the installation of a pump. Write for complete information.

Exterior of the new boiler house. Initial operation at 165 lbs. pressure to tie in with equipment in original boiler house, at right.



De Laval boiler feed pumps and Dravo fabricated piping are part of the equipment installed by Dravo.

Dravo Corporation, Department C-2110
Fifth & Liberty Avenues
Pittsburgh 22, Pa.

I am interested in Dravo Construction Services for _____

☐ Please send Bulletin #1200

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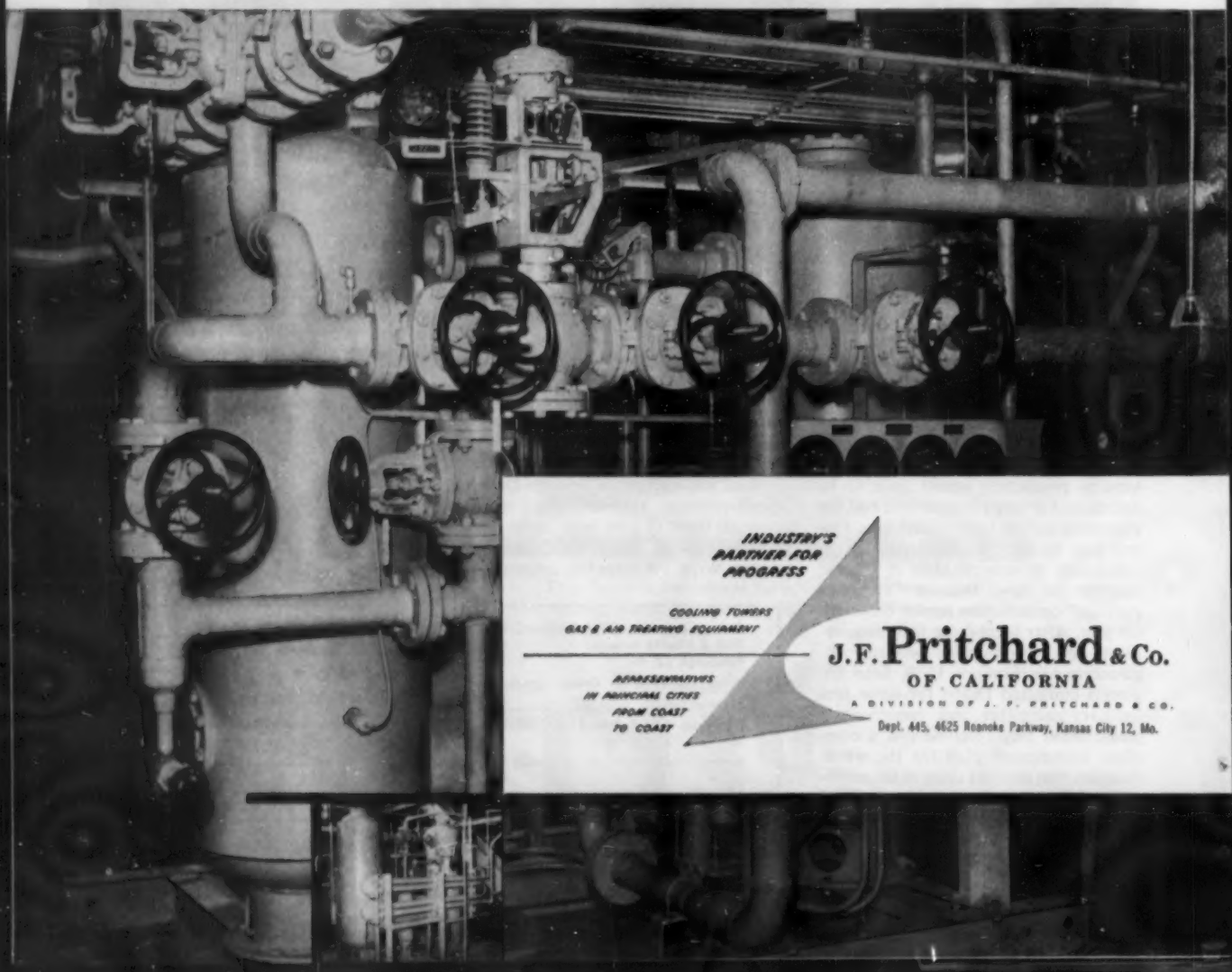
Pacific Gas & Electric, San Francisco, Calif., uses a Pritchard HYDRYER® to dry instrument air at their Contra Costa Steam Plant, Antioch, Calif. The HYDRYER receives air from instrument air receivers and discharges into a single header supplying the plant instrument and control air system.

This packaged, Pritchard unit continuously delivers air with a dew point temperature not in excess of −20°F. capacity, 420 CFM at standard conditions; pressure 100 psig; temperature, 80°F.

The many repeat orders on HYDRYERS prove their performance record in the drying of instrument air and other gases in many industries. Find out more about these dependable, packaged dehydration units by writing for bulletin 16.0.081 today!



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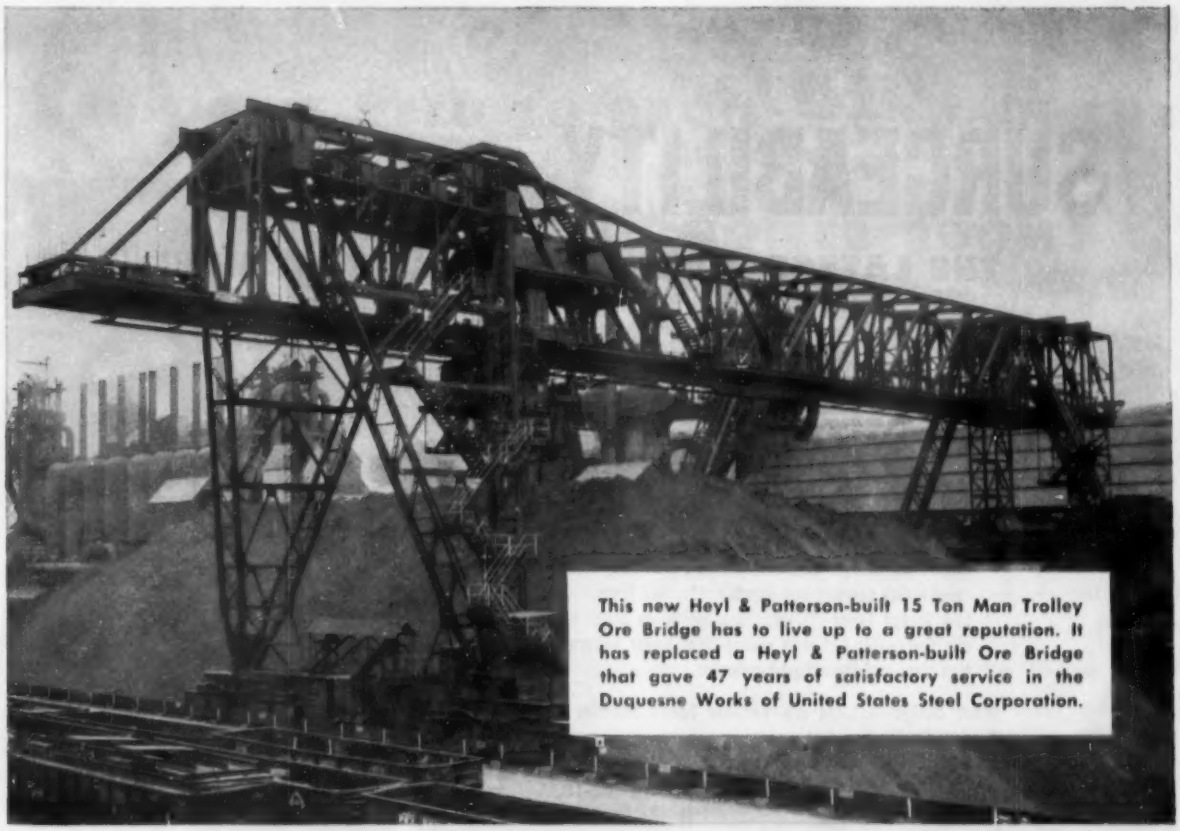
A DIVISION OF J. F. PRITCHARD & CO.
Dept. 445, 4625 Roanoke Parkway, Kansas City 12, Mo.



This new Heyl & Patterson-built 15 Ton Man Trolley Ore Bridge has to live up to a great reputation. It has replaced a Heyl & Patterson-built Ore Bridge that gave 47 years of satisfactory service in the Duquesne Works of United States Steel Corporation.

Heavy Materials-Handling Equipment

Specially Engineered For Your Requirements

"All the Way from Design to Satisfactory Operation" is a time-tested plan wherein each essential function from design to successful operation is performed by one organization.

The successful application of this plan of operation has developed a spirit of teamwork on the part of the Heyl & Patterson engineering, production (structural and machine shops) and erection departments.

This teamwork makes possible the execution of our contracts for Heavy Materials-Handling Equipment with assurance of satisfaction to our customers.

- **Ore & Coal Bridges**
- **Rotary (and other types of) Car Dumpers**
- **Boat Loaders & Unloaders**
- **Conveying Systems (Coal, Coke & Ore)**
- **Sintering Machines & Plants**
- **Pig Casting Machines**
- **Bradford Breakers**
- **Thorsten Sampling Equipment**
- **Liquid Cyclones**
- **Rail Clamps & Buffers**
- **Reineveld Centrifugal Fine Coal Driers**

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THE LATEST WORD IN WATER TREATMENT

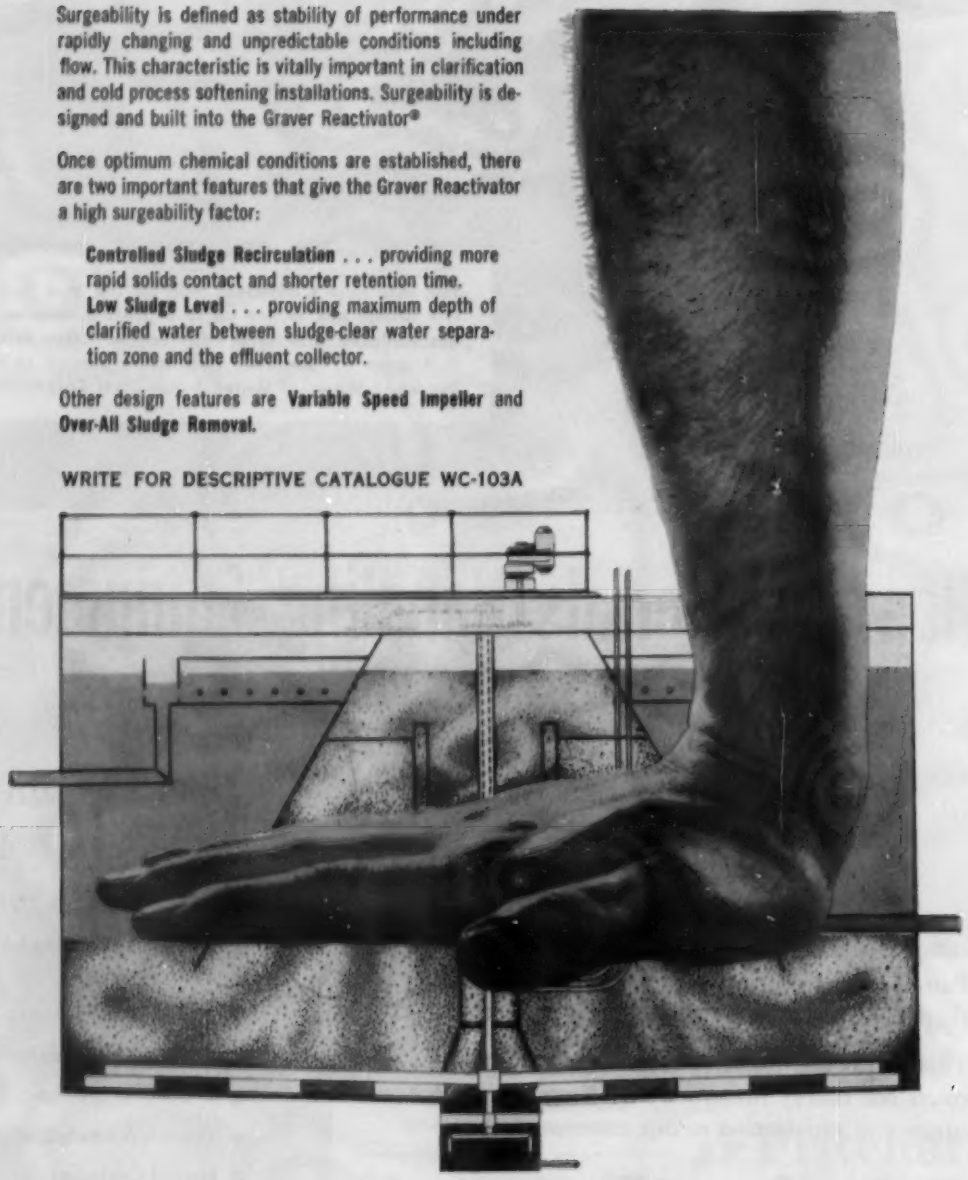
Surgeability is defined as stability of performance under rapidly changing and unpredictable conditions including flow. This characteristic is vitally important in clarification and cold process softening installations. Surgeability is designed and built into the Graver Reactivator®

Once optimum chemical conditions are established, there are two important features that give the Graver Reactivator a high surgeability factor:

Controlled Sludge Recirculation . . . providing more rapid solids contact and shorter retention time.
Low Sludge Level . . . providing maximum depth of clarified water between sludge-clear water separation zone and the effluent collector.

Other design features are **Variable Speed Impeller** and **Over-All Sludge Removal.**

WRITE FOR DESCRIPTIVE CATALOGUE WC-103A

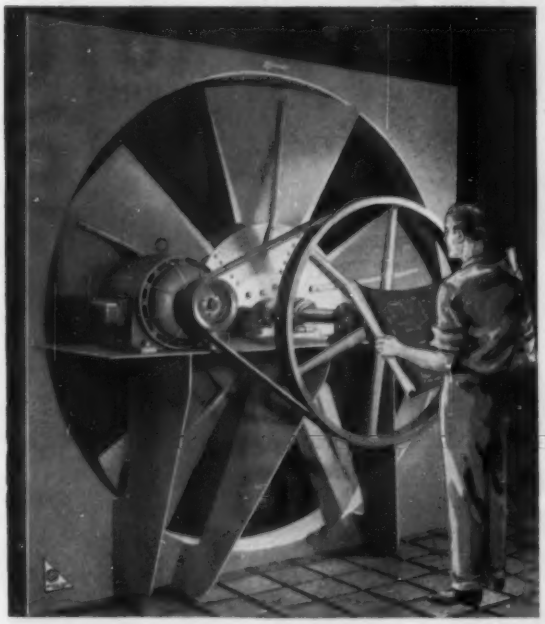


Department NK

GRAVER

GRAVER WATER CONDITIONING CO.
A Division of Graver Tank & Mfg. Co., Inc.
216 West 14th Street, New York 11, N. Y.

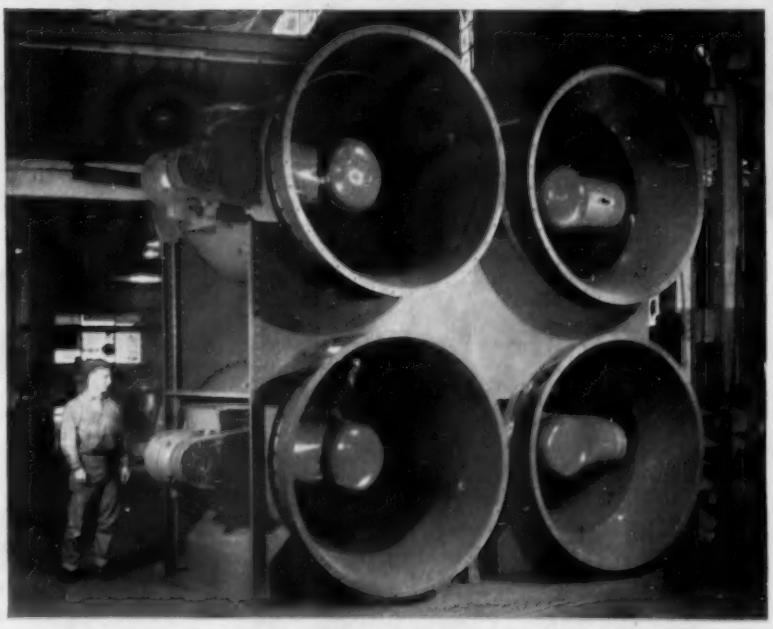
YOU DON'T NEED TO BROIL IN THE BOILER ROOM!



"BUFFALO" PACKAGE PROPELLER FANS are giving excellent results in removing excess heat from boiler rooms of large utility stations and industrial power plants — efficiently "moving out" large volumes of hot air to make boiler rooms cool, pleasant places to work in. The large 96" Package Propeller Fan shown is typical of the unusual efficiencies in this popular "Buffalo" line. Moving 80,000 cfm at ¼" static, it requires only a 15 H.P. motor. These fans operate against as high as 1" pressure, and sizes range up to 144" (this 12-foot wheel delivering 250,000 cfm!). For the economical answer to boiler room cooling, write today for BULLETIN FM-1234.

"BUFFALO" AXIAL FLOW FANS, too, are becoming increasingly popular with power plant operators because of their extremely high efficiency, light weight and suitability for duct mounting. If practical, heated air from the boiler room may be distributed to other areas by duct. These fans have the "Limit-Load" horsepower characteristic — they cannot be overloaded. At right is a 4-fan "package" unit now effectively cooling a prominent power plant. WRITE FOR BULLETIN 3533-C. In all "Buffalo" Fans, you get a built-in value known as the "Q" Factor* — the product of 78 years of air handling experience.

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*



"BUFFALO" ALSO BUILDS the Induced Draft, Forced Draft, Primary Air, Gas Recirculating and other Fans that are helping to produce economical power for many of the country's best-known installations. WRITE FOR BULLETIN 3750.

BUFFALO FORGE COMPANY

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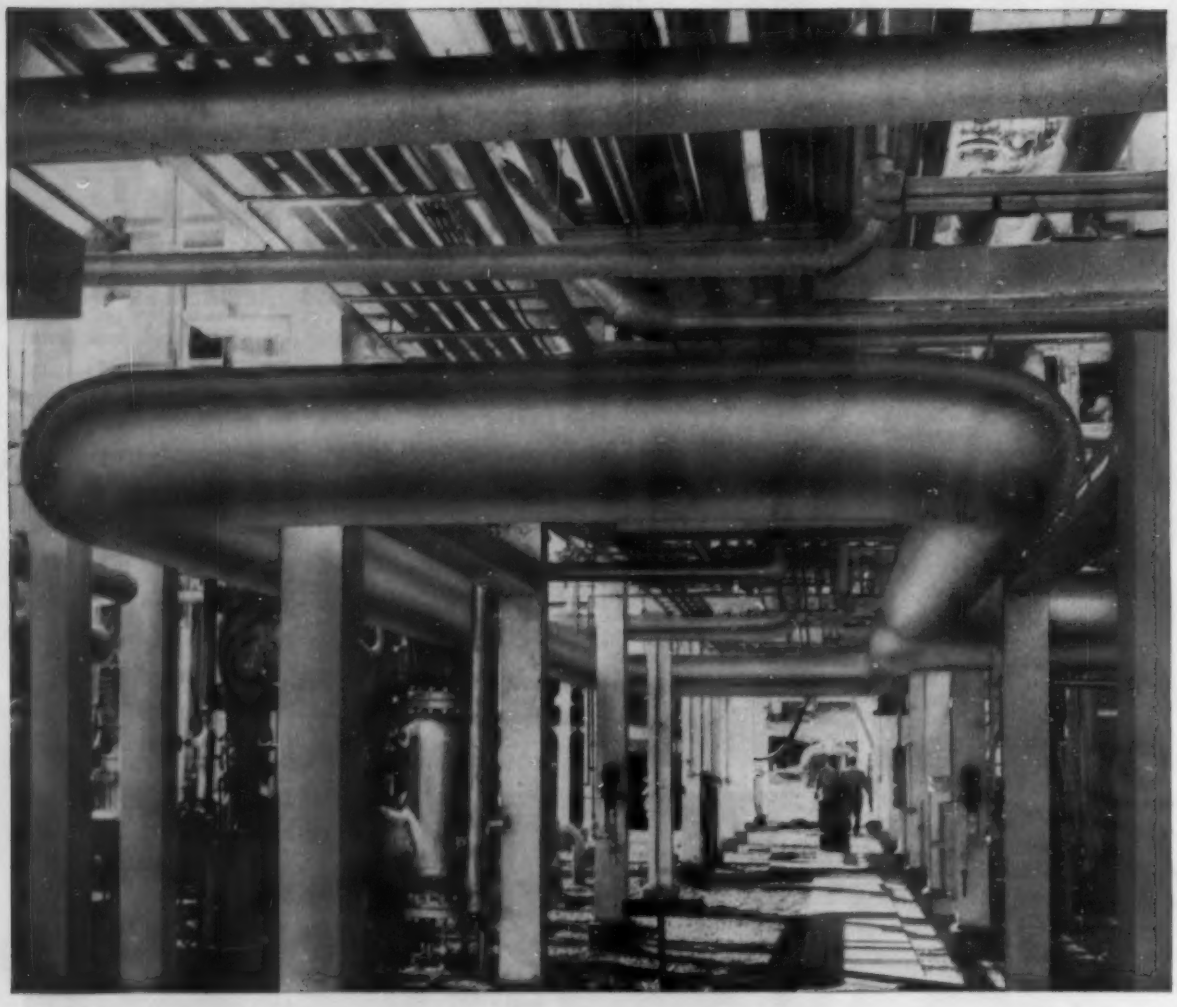

Less heat loss at joints with single-layer Unibestos® Pipe Insulation

Tests prove that Unibestos single-layer pipe insulation actually provides greater protection than other nonfibrous *double-layer* insulations which cost more to install. Unibestos is made of Amosite—the long-fibered African asbestos. These fibers interlock with one another to prevent heat loss at horizontal and longitudinal joints.

While most insulating materials show a pronounced shrinkage at high temperatures, Unibestos has no measurable shrinkage at 1200°F. It will not powder, pulp or wash off, even under heavy moisture conditions, and when dry, Unibestos resumes its original thermal and physical characteristics.

EASY to install . . . easy to remove.

Unibestos can be cut, mitered and handled easily. The fabrication of insulation for tees, valves, flange covers, etc., is a fast, low-cost operation. Because of its unusual strength and durability Unibestos can be removed and replaced with little or no loss of material.

STANDARD PRODUCTION SIZES

Unibestos Pipe Insulation is regularly made in 3-foot lengths for pipe sizes from ½″ through 24″, in standard thicknesses through 5″. Unibestos Block Insulation is made in 6″, 12″, 18″ or 36″ widths and in thicknesses from 1″ through 3″ in ½″ increments.

For complete information, write for descriptive Bulletin 109C

UNARCO

UNION ASBESTOS & RUBBER COMPANY
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24 ACRES *Cover the World*

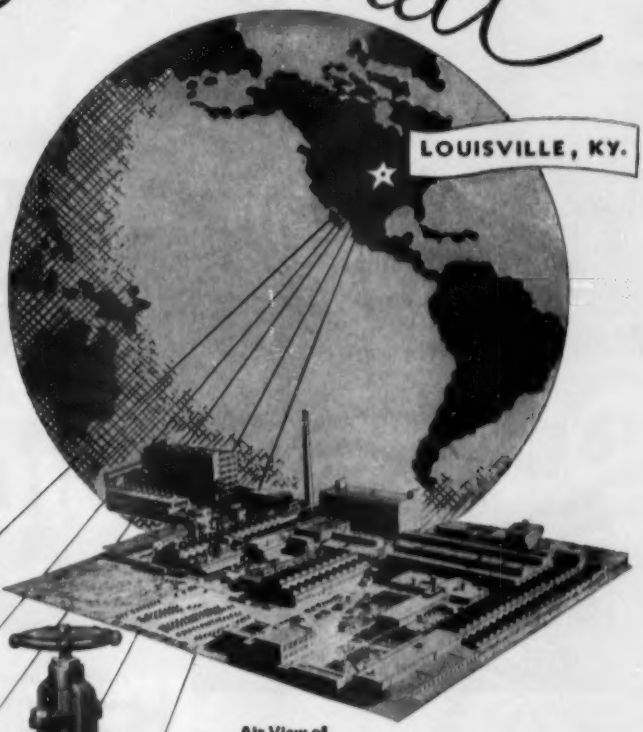
. . . with TOP QUALITY

DROP FORGED STEEL

VALVES, FITTINGS and FLANGES

by

Vogt



Air View of
Henry Vogt Machine Co.

This 24 acre Vogt plant supplies the most comprehensive line of top quality *drop forged* steel piping materials anywhere available to industry. That's why they're the choice of leading refineries, power plants, chemical plants, etc., the world around!

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TISHMAN REALTY AND
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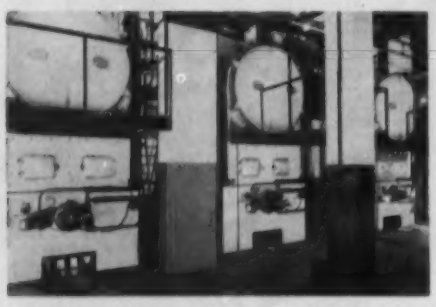
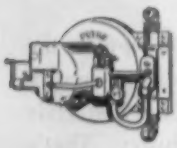
20 PETRO OIL BURNERS

IN TEN BIG NEW YORK BUILDINGS



Sutton Terrace (shown at top) consists of three 12-story buildings accommodating 495 families. Heat is supplied by three Titusville boilers, each rated at 42,500 sq. ft. of radiation and each fired with a WD 8 AH Petro burner. This installation has three 15,000 gallon, 10 ft. diameter fuel storage tanks.

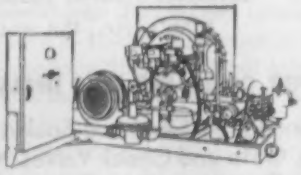


ROTARY OIL BURNERS

Horizontal rotary oil burners make possible substantial fuel savings by burning the low-cost heavy fuel oils with complete dependability. Models for every industrial need. Capacities up to 600 boiler horsepower.

COMPLETE PACKAGED UNIT

A complete forced draft combustion system with all parts factory assembled and tested. Saves installation time and cost, gives top performance and fuel economy.



***"Petro oil burners give us the cleanliness, dependability, and economy of operation we require,"* says Alan Tishman**

Providing heat for 9 huge apartment developments and power for a 13-story manufacturing plant is a tremendous responsibility, but Tishman Realty and Construction Co. Inc., have found that they can rely on Petro oil burners to do the job. "The ability of our Petro oil burners to immediately respond to fluctuating heat and power demands without over-firing or under-firing is a vital factor in keeping our fuel costs low and our tenants happy," says Mr. Alan Tishman.

Oil automatically preheated for sure firing and lower fuel cost To insure quick positive starting and steady, uniform firing, Petro oil burners automatically *preheat* oil to an efficient temperature before it is injected into the firebox. This Petro method of preheating oil also enables users to burn the heavy fuel oils (Nos. 5 & 6), which average 8% richer in heat value, without complicated mechanical gadgets that cause service and adjustment problems. You save worry *and* money with Petro oil firing.

PETRO oil burners are adaptable to any boiler room

Petro industrial oil burners are designed and built to *modernize* the firing of your present boilers. The flame is adjustable to any firebox, and the installation is adaptable to any boiler room layout. This means that you save substantially on initial installation costs, and save more money every day on fuel and labor costs. Mail coupon for free catalog and information.

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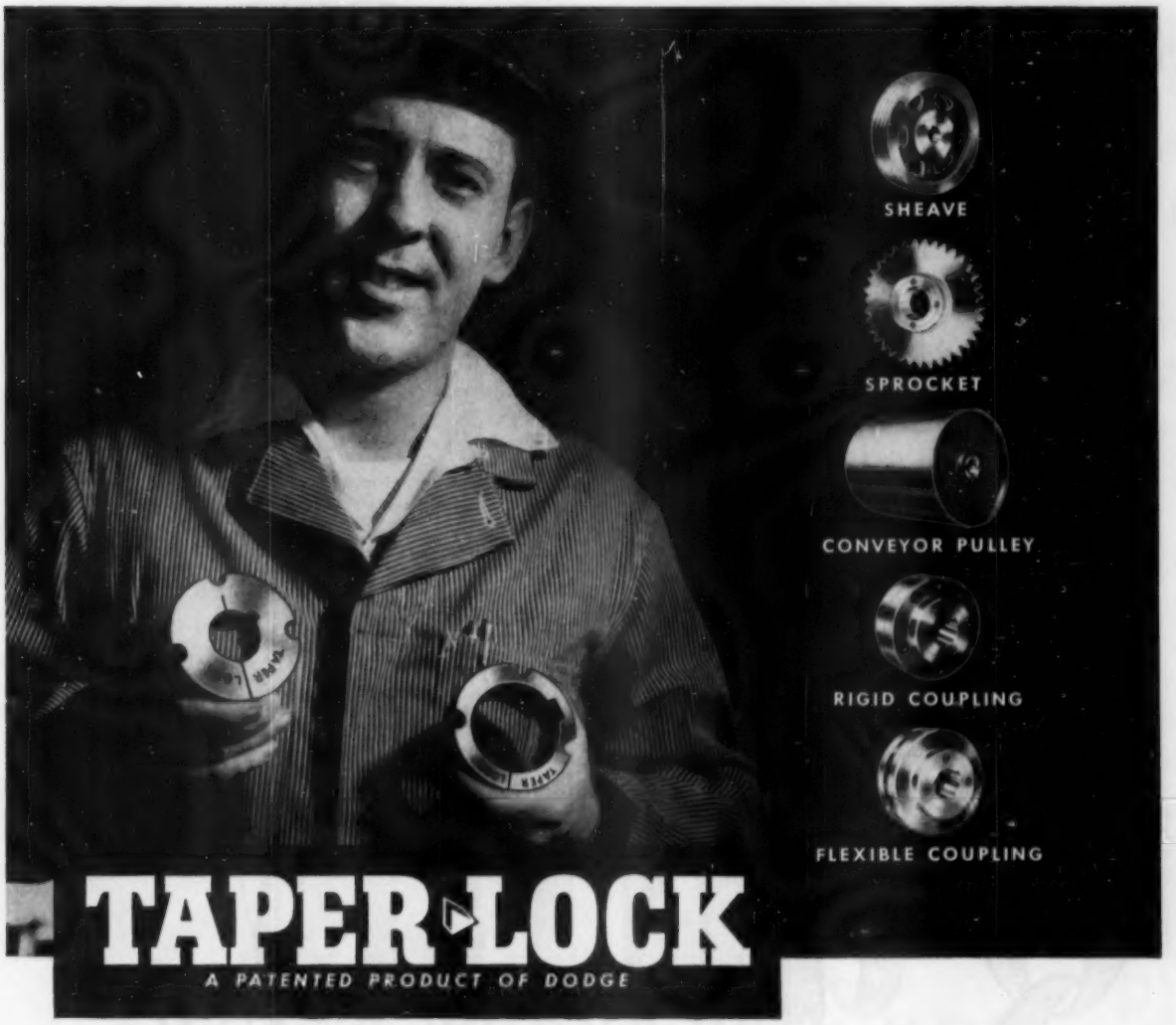
OVER 50 YEARS OF LEADERSHIP IN AUTOMATIC HEATING AND POWER EQUIPMENT



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A PATENTED PRODUCT OF DODGE

"Brother...you sure can save with these interchangeable bushings!"

With a few Taper-Lock bushings you can make quicker changes and cut down-time on production machines—because Taper-Lock bushings are *interchangeable*. Shift from a Dodge sprocket to a Dodge sheave, and use the same bushing! Taper-Lock bushings are available in a range of sizes which makes changing from one size shaft to another equally easy and quick.

Mount 'em all with Taper-Lock bushings—your sheaves, sprockets, couplings, conveyor pulleys. They slip on the shaft quickly—hold with the firmness of a shrunk-on fit—come off easily without shock to bearings or machinery. Standardize, economize with Taper-Lock.

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THERE'S ONLY ONE TAPER-LOCK, THE BUSHING THAT MOUNTS FLUSH!

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified telephone directory, or write us.

DODGE

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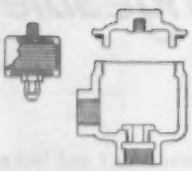
STEAM TRAP

Quality



Just 3 quality parts—thermostatic bellows, body, cap. Simple, positive action. Won't leak!

Nicholson quality . . . that gives you the extra strength, extra capacity, extra *stamina* required for severest steam distribution service. Nicholson quality pays off, when it comes to discharging condensate and air from steam lines . . . most efficiently, dependably, economically.

- **Powerful valve action—big husky bellows.**
- **Positive shut-off—finely ground valve and seat.**
- **High capacity—large diameter orifice.**
- **Rigidly tested—on actual steam lines.**

When less than best won't do, specify Nicholson. Send for *Catalog 953*.

NICHOLSON

W. H. NICHOLSON and Company

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Nothing . . . except that it's so rarely found in its pure state. Even rain, nature's closest approach to pure water, contains carbon dioxide and dissolved oxygen. So it is, in varying degrees, with every surface or underground water supply. All waters have certain corrosive impurities that must be corrected or neutralized before they can be economically used. That's where we come in.

Since 1887, Dearborn has worked with water to make water work better and more economically for you. That's why, today, industrial and commercial businesses of every size and type look to Dearborn for consultation and assistance in problems like—

- ☆ **Internal or external feed water treatment**
- ☆ **Steam purity control**
- ☆ **Feeding, softening or de-ionizing equipment**
- ☆ **Cooling water or process water treatment**
- ☆ **Water reclamation**
- ☆ **Industrial waste treatment**

This broad experience of Dearborn's is available to you. Your Dearborn Water Treatment Engineer will gladly explain the advantages of Dearborn Supervisory Service—a program in which you use only the amount of service you need.

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MERCHANDISE MART PLAZA • CHICAGO 54, ILLINOIS

Dearborn Chemical Company, Dept. PO
Merchandise Mart Plaza, Chicago 54, Illinois

☐ Please furnish more information on Dearborn Water Conditioning

☐ Have a Dearborn Water Treatment Engineer call

Name.....*Title*.....

Company.....

Address.....

City.....*Zone*.....*State*.....

HOW TO BUY CONVEYOR BELTS

and get...
MORE USE PER DOLLAR
where
SPECIAL ENGINEERING
is needed

Look for a make of belt backed by experienced, specialized engineering service.

Selecting the right conveyor belt to solve a special problem begins with selecting the right representative . . . one who will take interest in your particular belt needs and refer your problems to his factory if engineering help is required. Where a company makes a wide selection of conveyor belts for many applications, the representative can often recommend a feature construction to meet your job requirements. Where your problem is unique, that company backs its field men with custom engineering and comes up with a recommendation to meet your specific operating conditions.

Choose the company that offers *complete* belt engineering service . . . the source of supply that maintains close contact between factory and field.

RAYBESTOS-MANHATTAN CONVEYOR BELT ENGINEERING

A leading steel mill, faced with handling hot sintered ore without an insulating layer of "fines", had numerous belt failures due to charring.

An R/M representative called in a factory engineer. A new custom-engineered R/M conveyor belt with special cover now saves hundreds of dollars a year at the mill.

and . . . where hot ash and clinker was wearing out a conveyor belt every month at a Michigan cement plant, an R/M field man was able to furnish a specially engineered Homocord Belt which has outlived the best previous belt four times over.

and . . . special, "chevron cleated" conveyor belt was developed by R/M, as a result of a field representative request, to replace a smooth surfaced belt unable to carry wet iron ore up a mine slope without costly spillage.

These are just a few of many instances where R/M engineering service has solved conveyor belt problems. In other cases, special job requirements have been met with R/M's exclusive constructions such as extra-flexible Ray-Man "F" . . . extra-cushioned Homocord for shock-loading . . . and Ray-Man Tension-Master for extra-high tensions and long lifts.

Let an R/M representative show you why R/M engineering makes R/M Conveyor Belts last much longer . . . give you "More Use per Dollar".

RM-502-A60

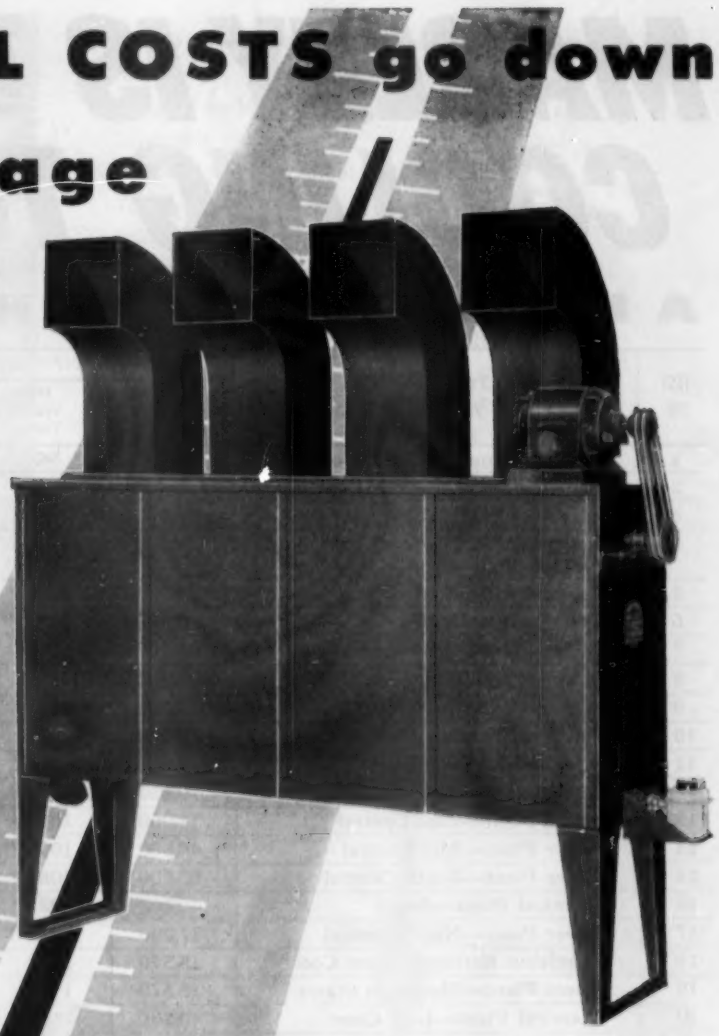
RM

MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Brake Linings • Brake Blocks • Clutch Facings • Asbestos Textiles • Packings • Engineered Plastic and Sintered Metal Products • Bowling Balls

YOUR FUEL COSTS go down when Clarage Unitherms go in...



AMONG the many prominent users — Sutherland Paper with 13 Unitherms and 48 Clarco Unit Heaters (suspended models for smaller area service) in its newest plant.

Exclusive Feature saves you money

Clarage's unique Syncrotherm Control maintains uniform heating with relatively low temperature air in constant circulation. By-pass dampers control the amounts of air passing through and around heating coil. Result: better use of each BTU at lower cost. Investigate this and the other features of the Unitherm Unit Heater — available for steam or hot water operation, floor or ceiling installation, in a wide size range. Write for Catalog 1115. CLARAGE FAN COMPANY, Kalamazoo, Michigan.

CLARAGE

dependable equipment for making air your servant

SALES-ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

MARLEY IS TESTING COOLING TOWERS

AND HERE IS THE RECORD

TEST NO.	TYPE OF SERVICE AND LOCATION	SPECIFIED CONDITIONS				TEST RESULT	
		Gallons Per Minute	Hot Water Temp.	Cold Water Temp.	Wet Bulb Temp.	[1]Degrees Cold Water Temp.	[1]Percent Capacity
1	Air Conditioning—West Coast	400	90°	80°	70°	+0.80°	+9.4%
2	Air Conditioning—Gulf Coast	6,500	101.3°	88.5°	80°	—0.40°	—4.3%
3	Chemical Plant—East Coast	18,500	104°	89°	76°	+0.50°	+3.8%
4	Chemical Plant—East Coast (1 of 4 duplicate units)	27,500	103°	88°	76°	—0.40°	—3.2%
5	Power Plant—Southwest	57,500	109.6°	92.6°	78°	—0.04°	—0.4%
6	Petroleum Refinery—Gulf Coast	3,400	115°	80°	70°	+0.90°	+8.5%
7	Power Plant—South Central	83,000	108.1°	90°	76°	—0.04°	—0.4%
8	Power Plant—Mountain States	45,000	105°	83.7°	63°	+0.20°	+0.8%
9	Petroleum Refinery—Gulf Coast	15,000	111°	90°	82.5°	+0.70°	+7.7%
10	Petroleum Refinery—Gulf Coast	36,570	120°	90°	82°	—0.60°	—4.4%
11	Power Plant—Southwest	70,450	102.6°	86°	70°	—0.86°	—4.4%
12	Power Plant—Southwest	70,450	102.6°	86°	70°	—0.51°	—2.7%
13[2]	Power Plant—East Central	13,000	101°	85°	75°	—3.70°	—24.3%
14	Power Plant—Mid-Central	44,000	100°	86°	74°	+0.50°	+4.0%
15	Power Plant—South Central	83,000	108.1°	90°	76°	—0.80°	—4.3%
16	Chemical Plant—South	40,000	103.3°	85°	78°	—0.30°	—3.0%
17	Power Plant—North Central	37,000	100.5°	83°	72°	+1.20°	+9.6%
18	Petroleum Refinery—East Coast	15,570	115°	85°	76°	+1.10°	+9.0%
19	Power Plant—Mountain States	15,570	115°	85°	76°	+1.10°	+9.2%
20	Chemical Plant—Gulf Coast	40,750	123°	90°	80°	—0.16°	—1.2%
21[3]	Chemical Plant—Gulf Coast	11,000	116°	90°	80°	+1.80°	+13.2%
22[3]	Retest of Tower Reported in No. 14	44,000	100°	86°	74°	+0.45°	+4.8%
23[4]	Retest of Tower Reported in No. 11	70,450	102.6°	86°	70°	+0.20°	+1.1%
24[4]	Retest of Tower Reported in No. 12	70,450	102.6°	86°	70°	+0.33°	+1.8%
25	Petroleum Refinery—East Central	6,000	125°	90°	75°	—0.46°	—2.6%
26[5]	Petroleum Refinery—Gulf Coast	10,000	120°	85°	79°	+0.30°	+3.2%
27	Power Plant—Southwest	72,000	112°	92°	78°	+1.05°	+6.6%
28	AEC—East Central (1 of 2 duplicate units)	62,798	132.3°	90°	80°	+0.31°	+3.5%

NOTES: 1) Plus indicates capacity exceeding specified performance; minus denotes deficiency. 2) Tested to determine loss of performance due to extensive settling of basin and resultant misalignment of structure. 3) Retested at higher wet bulb. 4) Retested at contract (higher) horsepower. 5) Tested in accordance with Cooling Tower Institute test procedure (ATP-105 adopted May 1, 1955) and observed by CTI representative.

HERE IS THE RECORD — a consecutive list of ALL acceptance tests conducted by Marley during the 1954-1955 test seasons. All are full-scale tests conducted in strict accordance with specified methods.

Towers tested were of many sizes and capacities, operating under widely varying conditions. Geographically, these tests spanned the entire country and included towers sold since 1950, located at elevations up to 5,000 feet.

HERE IS THE RECORD that offers **more positive assurance of performance satisfaction than any guarantee ever written.** It shows why Marley has the complete confidence to insist that you TEST YOUR TOWER.

MARLEY

The Marley Company

Founder-member of the Cooling Tower Institute

Kansas City, Missouri

NO Reducing Valve Needed

Here's real economy in temperature control.

Because Spence Temperature Regulators are designed to limit heater steam pressures to an adjustable maximum, the need for a separate reducing valve is completely eliminated.

The Spence Regulator takes steam directly from the boiler or high pressure line, reduces the pressure and regulates the flow as required to maintain a constant temperature output from the heater.

This means one relatively small combination pressure and temperature regulator replaces a reducing valve of the same size and a larger temperature regulator. Practically the entire cost of the large separate temperature regulator is saved. And, the total saving would also include the cost of a 3-valve by-pass along with all labor for installation.

This design feature is just one of the reasons for the thousands of Spence installations throughout American industry. *For details of other important design features, write for Bulletin T50.*

SPENCE
TYPE ET150
Temperature
Regulator

Spence

SPENCE ENGINEERING COMPANY, INC.
WALDEN, NEW YORK

Jeffrey puts VIBRATION to useful work

YOU CAN SOLVE many flow-control problems with Jeffrey Electric Vibrating Feeders. They provide highly efficient regulation of the flow of coal from hoppers and bins to conveyors, elevators, crushers, jigs and so on. Coal is propelled in a smooth, continuous stream by each forward vibration stroke.

Balanced vibration in the Jeffrey system matches electrical frequency to the natural mechanical frequency of the driven equipment. This makes the system economical to operate, since all available energy does useful work. It is easy to control, safe, quiet and dependable. Vibration is isolated within the conveyor by scientifically designed supports.

Jeffrey's years of experience with conveying problems enable us to furnish systems exactly right for each particular task. Catalog 870 describes the complete line of Jeffrey Vibrating Equipment. For a copy, and for help on your conveying problems, write The Jeffrey Manufacturing Company, Columbus 16, Ohio.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT • TRANSMISSION MACHINERY • CONTRACT MANUFACTURING

3:59.4 or 4:01.4

There's enough difference To make all the difference

A difference of only 2 seconds . . . but it made sports history on May 6, 1954, when the first under-four-minute mile was run in Oxford, England.

The differences in quality and performance that Scovill builds into its Heat Exchanger Tube, while they also may seem small, can make a *big* difference in improving your operating record. Scovill Phosphorized Admiralty Heat Exchanger Tube, for example, begins its long service life with an added advantage. It is initially hot-extruded from billets *continuous-cast* by Scovill's pioneer process. This means sounder metal — smooth, dense, free from pits or porosity. It means new uniformity of chemical composition, with optimum and uniformly distributed phosphorus content.

The next time you have a new installation or a re-tubing job, let us show you how these differences in Scovill Heat Exchanger Tube work for you.

Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

SCOVILL **HEAT EXCHANGER TUBE**

Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Muntz Metal • Naval Brass • Red Brass, 85% • Deoxidized Copper
Arsenical Copper • Copper Nickel, 10% & 20% • Cupro Nickel, 30% • Aluminum Brass • Aluminum Bronze, 5% • Duplex Tube

138C55

FOR EFFICIENT CONTROL OF RISING INDUSTRIAL TEMPERATURES

KAYLO—*King of high temperature insulations*

FIBERGLAS—*World's leading industrial insulation*

Together they answer all your insulation needs!

Average temperatures of industrial processes have increased to 500-700° F. from 350-500° in the past several years. Indications are that they'll go even higher in the future.

With Fiberglas* and Kaylo* Insulations, present and future temperatures can be efficiently controlled without adding undue bulk or cost. Both products have exceptionally low "k" factors. They're strong . . . moisture-resistant . . . stable . . . easy to apply . . . cover the entire range from lowest sub-zero to 1200° F.

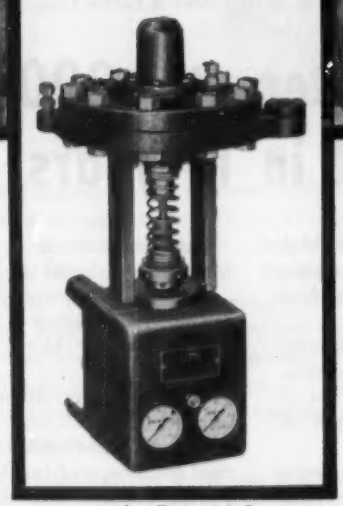
Kaylo is now distributed by Owens-Corning Fiberglas Corporation, and is available in quantity. For full technical data on Fiberglas and Kaylo, see Sweet's File, Chemical Engineering Catalog, or Refinery Catalog. Or write: Owens-Corning Fiberglas Corporation, Dept. 186-J, Toledo 1, Ohio.

OWENS-CORNING FIBERGLAS

*T.M. Reg. Owens-Corning Fiberglas Corporation
® Kaylo is mfd. by Owens-Illinois Glass Co., Inc.

Here's the *pilot* with the *sense* to save *dollars*

Close Control



Leslie Type LA-2
Level Control Pilot

EXTRACTION TYPE FEEDWATER HEATER DRAIN CONTROL
This Leslie liquid level controller is installed in heater drain service in a Midwest utility station. You will also find Leslie liquid level controllers in condenser hot well service, de-aereating heater installations and boiler level control.

Leslie Floatless Level Control Pilots sense changes in liquid level that will help you maintain peak output. You save maintenance dollars, too — forget troublesome floats and cages (there aren't any).

With low resolution sensitivity (.1 of an inch change in level creates response), you are assured of smooth, throttling action and a closely held level.

There are Leslie Pressure Control and Temperature Pilots with the sense to save dollars in pressure and temperature control stations, too. Your Leslie Engineer, listed under "Valves or Regulators" in your classified directory, will be glad to help you.

Send for Bulletin 5303 on Leslie Control Pilots

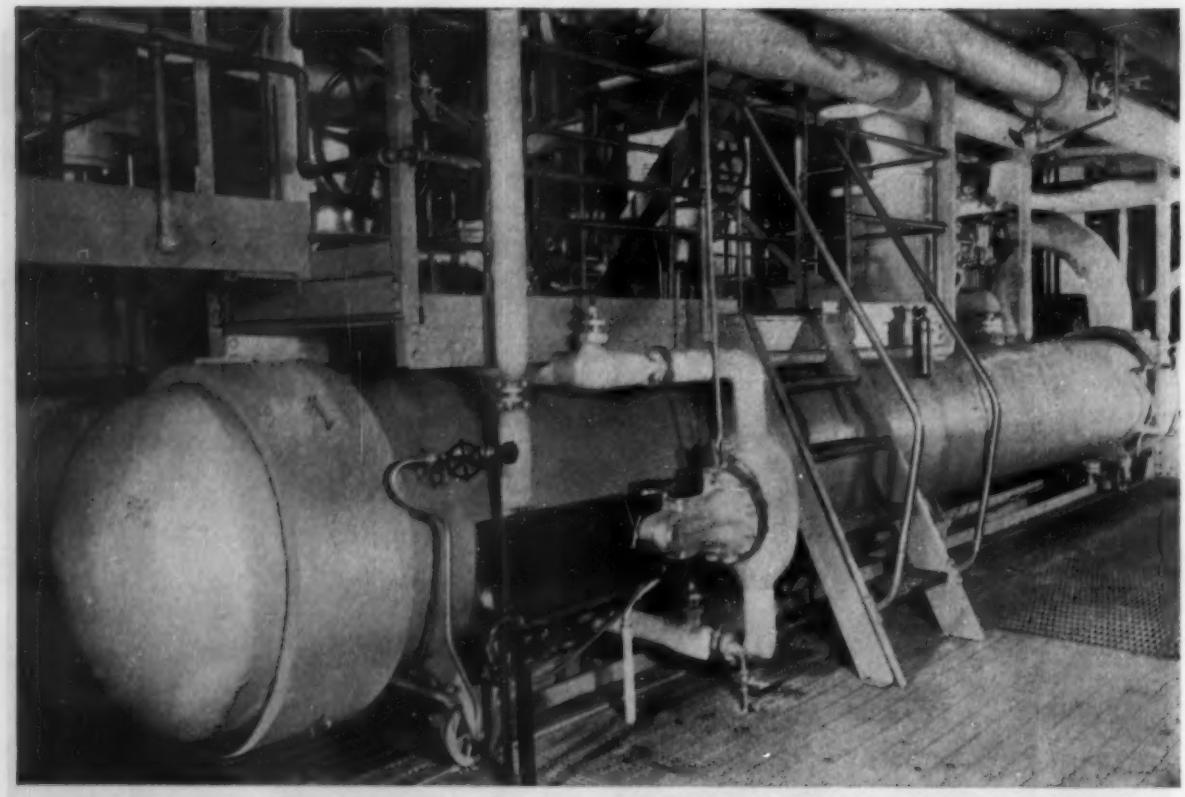
TRADE LESLIE MARK

REGULATORS AND CONTROLLERS

LESLIE CO., 235 GRANT AVENUE, LYNDHURST, NEW JERSEY

P.8573

CONTROLLED QUALITY MEANS QUALITY CONTROLS



Installed in 1941 this cross-over feedwater heater is one of two Monel-tubed units that feed a boiler generating 2,500 psi steam at 1,000°F. Still in first class condition, these pioneer heaters continue to serve American Gas & Electric at Twin Branch, Ind. Both heaters were built by Foster Wheeler Corp.

Monel tubes feed 490° water at 3,200 psi without a replacement in 14 years

14 YEARS AGO there was no precedent for feeding high pressure boilers that generated 2,500 psi steam at 1,000°F.

When The American Gas & Electric System decided to extend its Twin Branch station, designers were not even sure of what heater tubing material they could safely use.

For here was a project requiring feedwater heaters to handle 550,000 pounds of water per hour at 3,200 psi maximum . . . and to raise water temperature from 355° to 490°F.

After much searching and testing, engineers found that one tube material —Monel* nickel-copper alloy—offered more than ample strength to withstand both the heat and pressure. Monel tubes offered corrosion and erosion resistance that assured this high strength over years of use. At the same time, this alloy also assured rapid heat transfer.

So American ordered two heaters from the Foster Wheeler Corporation . . . each to have 316 Monel tubes of ¾" O.D. with a heating length of 29 feet.

Since their installation, 14 years ago, not a single Monel nickel-copper alloy tube in either heater has been plugged or replaced. Moreover, there's been no unscheduled downtime for repairs because of tubes. In February 1955, American Gas & Electric reported "... the Monel tube bundles are in good condition and should last indefinitely."

This performance is good reason why you, too, should use Monel tubing . . . for excellent strength, corrosion and erosion resistance, and a coefficient of expansion close to that of steel tube sheet.

You can order Monel tubing in lengths up to 85 feet. Get all the facts about Monel nickel-copper alloy. Send for a copy of Inco's T-5, "Engineering Properties of Monel." Write for it now. *Reg. Trademark

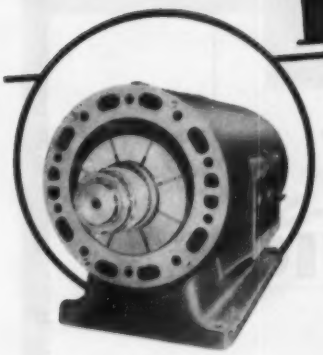
The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

50 YEARS OF Nickel Alloy Progress PIONEERED BY MONEL 1905-1955

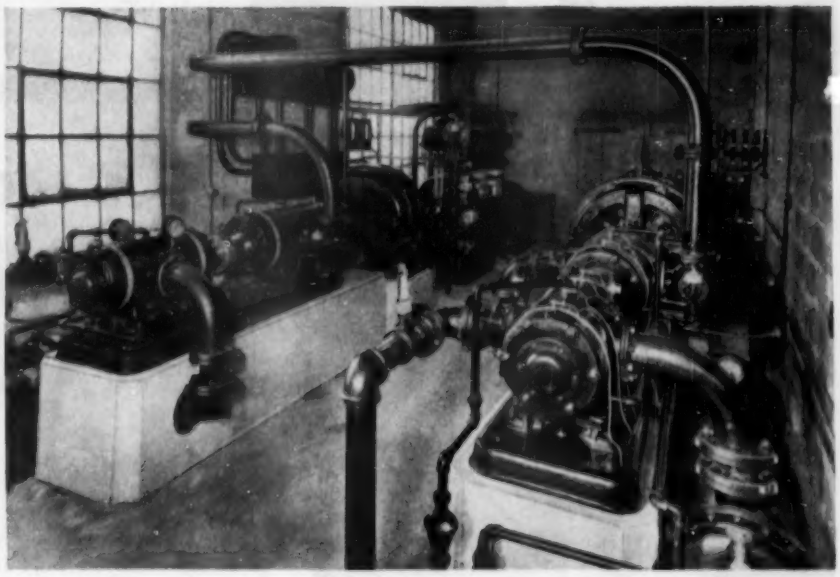
More POWER for you...with MONEL

INCO TRADE MARK NICKEL ALLOYS

Fuller *pioneered*



the two-stage **rotary** compressor . . . for general industrial use . . . starting in 1930



INSTALLED 1930
STILL GOING STRONG ➡
Two Fuller Rotary Two-stage Compressors. Capacity each 740 c.f.m., 100-lb. pressure.

Fuller Company not only pioneered the rotary compressor for industrial use in this country, but it has always stressed the "spotting" of compressors. There's nothing new or startling about this principle . . . Fuller has advocated it ever since its first machines were put on the market in 1930 . . . applying each compressor to a specific job, with resultant overall plant economy, as well as power savings. Result: the adoption of this economical layout by thousands of users has proved to their satisfaction the soundness of such a program.

Fuller has built and sold thousands of Fuller Rotaries—a large proportion of the two-stage type. And, when plant expansion is necessary, with a consequent demand for more air, additional Fullers are naturally installed.

Fuller engineers have never rested on their oars, but have continually worked to improve design and efficiency, until today, these machines are second to none for dependable air-production in industry.

We welcome the opportunity to present to you all the facts concerning Fuller Rotary Compressors, facts built on actual operational experience. For a complete description of Fuller Rotaries, write for Bulletin C-5A.

FULLER COMPANY, Catasauqua, Penna.
GENERAL AMERICAN TRANSPORTATION CORPORATION SUBSIDIARY
Chicago • San Francisco • Los Angeles • Seattle • Birmingham

C-275
1783

Fuller

PIONEERS OF HIGH-EFFICIENCY VANE TYPE ROTARY COMPRESSORS SINCE 1930

EASY TO SERVICE...

a plus value of ASHCROFT

Maxisafe DURAGAUGES

Turn the knob on the back of the *Maxisafe* and the plate comes off, fully exposing the entire mechanism for fast and easy inspection, recalibration or adjustment. This time and money-saving feature is highly favored wherever Ashcroft *Maxisafe* Duragauges are in service.

This Duragauge was named *Maxisafe* because it has an integrally-cast wall to separate the dial from the movement and Bourdon Tube assembly — a solid wall of safety that protects the viewer if the tube ever ruptures. Covering the back of the case is a double spring mounted safety release plate — a Teflon-coated plate tightly fitted on a rubber gasket and held in place by a knurled knob. Less than 0.5 psi pressure created by a ruptured tube forces this cover open — vents the discharge safely to the rear.

The Maxisafe is available in 4½", 6" and 8½" dial sizes. You can have a choice of standard Ashcroft Duragauge pressure ranges, case designs (except Types 1179 and 1279), and mountings. Get the utmost in sustained accuracy, durability, protection and convenient servicing. Specify Ashcroft *Maxisafe* Duragauges.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR has complete facts about Ashcroft Gauges of all types. You can depend on his knowledge and experience to help you satisfy every requirement of the application. He maintains local stocks to serve you promptly and economically.

1850 ASHCROFT U.S.A.

ASHCROFT GAUGES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

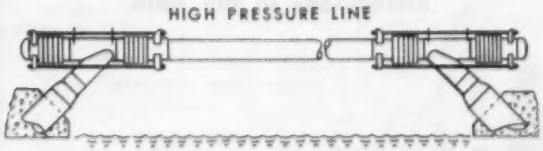
MAKERS OF 'ASHCROFT' GAUGES, 'AMERICAN' AND 'AMERICAN-MICROSEN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

Badger

Expansion Joints

Typifying Expansion Joint Engineering At its Best

THE "*Balanced*" JOINT



Picture a pipe line not only "hot" but also under high pressure. At any point where the pipe line changes direction abruptly, two distinct problems are involved: the usual thermal expansion but equally important, the terrific thrust created by the line pressure. Some means must be provided for 'holding' the pipe which in most installations can be securely anchored to a supporting structure. There are cases however, when this is not possible.

How can such a problem be handled?

This "Balanced" joint was designed for just such unusual problems. The unit consists of two joints tied together with four heavy rods. One end of the unit which is anchored at the center is blanked off. The rods balance the internal pressure. Thus, the only force exerted on the intermediate anchor is the force required to open and close the joints.

During the past few years we have engineered a number of these "Balanced" joints. The joint illustrated above was designed for use on a turbine, where it was necessary to reduce the stresses on the turbine casing. In another typical case (see sketch) "Balanced" joints were used to relieve the stresses on a bridge carrying a high pressure gas main. The anchor force was reduced from 245,000 pounds to 14,000 pounds.

This same engineering skill and flexibility in thinking is back of the other special joints as well as standard packless, corrugated joints with which the name Badger has for so long been associated. These are the joints you can trust to serve you well.

BADGER MANUFACTURING COMPANY

Original and Sole Manufacturer of Badger Expansion Joints

230 BENT STREET · CAMBRIDGE 41, MASS.

Loosens FROZEN PARTS FAST!

Handy
Won't
Leak
Shoots
3 Feet

Same formula as famous Kroil that has pleased 14,000 industrial users for 10 years or more.

Loosens stuck together metal parts, bushings, bearings, belts, screws, pipe, etc., "anything from an embalmer's needle to a bulldozer," one customer said.

"Like an extra employee," said another. "Turned rust into mush, put $50,000 equipment back to work."

You too can get these results.

Try Aerokroil at our risk. Send $2 cash, and we'll pay postage.

12-OZ. CAN $2.
F.O.B. NASHVILLE
CASE OF 12 $18.75

KANO LABS. 1053 S. Thompson Lane Nashville 11, Tenn.

This is NO Perfume Ad

but we can sweeten your air and save you money!

Chances are, when your refrigerating system is being purged, you can smell refrigerant gas. That smell indicates:

1. **You are losing valuable refrigerant gas.**
2. **You are not getting efficient purging of all the air in the system.**
3. **You are wasting power.**

With an Armstrong Purger, one ice cream manufacturer reported head pressures reduced 40 lbs. and power costs cut 20%. Another saved $255 in ammonia the first year. Still another saves $500 in ammonia annually.

It's really worth looking into. *Send for Bulletin No. 2211.*

ARMSTRONG MACHINE WORKS
812 Maple Street, Three Rivers, Michigan

Write For POWER'S "Reprint Folder"

Giving summaries and prices on Power's famous

SPECIAL REPORTS

the best condensed handbooks in the field

10/55

POWER, 330 West 42 St.,
New York 36, N. Y.

Gentlemen: Please send me a copy of Power's "Reprint Folder"

Name .....

Address .....

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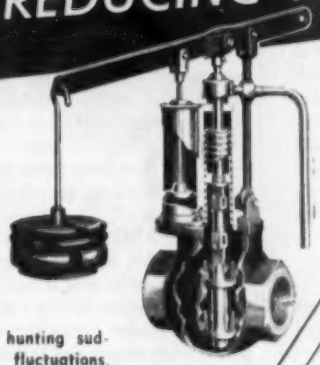
? ? DIAPHRAGM? STUFFING BOX? ?

NO!

? SPRINGS? ?

TO KEEP LIQUIDS ON-THE-LEVEL

Klipfel NO. 1 REDUCING VALVE

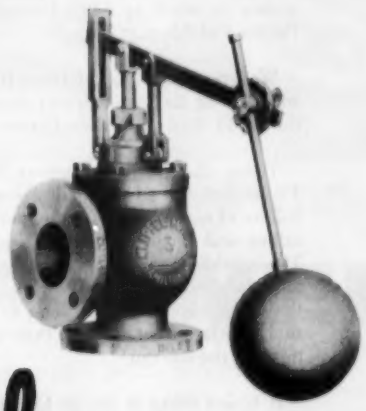


A forty year service record on steam lines throughout the land proves the Klipfel No. 1 Reducing Valve to be completely dependable . . . thoroughly troubleproof. A piston and dash pot valve, the No. 1 has no springs . . . no diaphragm . . . no stuffing box . . . no trouble points. Oil filled dash pot prevents hunting sudden valve movements and pressure fluctuations. Reduced pressure is easily adjusted by changing weight. Suitable for any reduced pressure between 10 and 150 pounds. Sizes 1½ inch have screwed ends; larger sizes have either screwed or flanged ends. Applications include main reduction to distributing head, auxiliary engines, vulcanizers, kettles, ironers, dryers, and pumps.

For complete details write Dept. D-10 for Bulletin No. 154.

Float Valves, Reducing Valves, Tank Thermostats, Back Pressure Valves

Sold through wholesalers everywhere.



Klipfel FLOAT VALVES

- For liquid level control that's really automatic, depend on Klipfel Float Valves. They have a forty year record of dependability on thousands of installations, large and small, water and chemical, throughout the land.
- Available in direct acting or pilot control types, either single seated or double seated. Whatever your requirements of pressure, temperature, fluid and closure, there is a Klipfel Float Valve for the job.
- Also available with Klipfel's exclusive cup disc inner valve for tight control of liquids injurious to rubber and leather, and for higher pressures.

Klipfel

Valves, Inc.
Division of
Hamilton-Thomas Corp.
Hamilton, Ohio

Export Dept:
1010 Schaff Bldg.
Philadelphia, Pa.

Klipfel VALVES INC.

- For complete details, write Dept. D-10 for Bulletin 254. Float Valves, Reducing Valves, Tank Thermostats, Back Pressure Valves.

Division of Hamilton-Thomas Corp., Hamilton, Ohio
Export Dept., 1010, Schaff Bldg.
Philadelphia, Pa.

ABC...and the Reader

BACK IN 1914—forty-one years ago—a group of advertisers, advertising agencies and publishers joined in a project that has come to mean a great deal to the millions who, like you, read business magazines. The project, initiated at a time when circulation claims were rarely verified, was intended to achieve and maintain higher standards of integrity in publishing and advertising practice by providing means to audit paid circulation. Out of that effort came an organization known as the Audit Bureau of Circulations, a voluntary, non-profit, cooperative association, known for short as ABC. Its symbol appears at the head of this page.

We are proud that McGraw-Hill publications were among the founders and charter members of the Audit Bureau of Circulations.

Today the Bureau numbers 3,670 members. These include advertisers, agencies, and publishers of newspapers, farm papers, general magazines and business journals such as this one. These publisher members hold their memberships and their right to display the ABC symbol in their publications only so long as they live up to the circulation standards that are established through the Bureau.

It is one thing to set up high standards; it is another to see that those standards are maintained. This latter and all-important function is performed by a staff of auditors maintained by ABC to check periodically on the circulation practices of the publisher members. When a business magazine, such as this one, joins the Bureau it agrees that the ABC auditors shall have "the right of access to all books and records." Their inspection may dig into the files of original subscription orders, payments from subscribers, paper purchases, postal receipts, arrears of payments, editorial expenses and many other significant items. Sometimes the auditors go behind the records and seek verification of purchase and payment from subscribers themselves.

The information thus obtained and certified by the Bureau then becomes available to the public and constitutes an authoritative report on the publication's circulation practices.

The advertisers and agencies benefit directly from the ABC because it provides a generally recognized factual yardstick by which the circulations of member publications can be measured and appraised. Every paragraph in an ABC report on a business publication gives the advertisers data that help them make intelligent use of the publication as an advertising medium.

But the ABC renders a service of vital concern to the *reader* as well. The Bureau audits paid circulation only, and it is through this payment, whether by subscription or newsstand purchase, that the reader keeps the editorial policy of a publication responsive to his needs. His decision to buy or not to buy records his judgment on each publication, and the ABC-audited and certified circulation reports make the sum of these judgments known to all concerned.

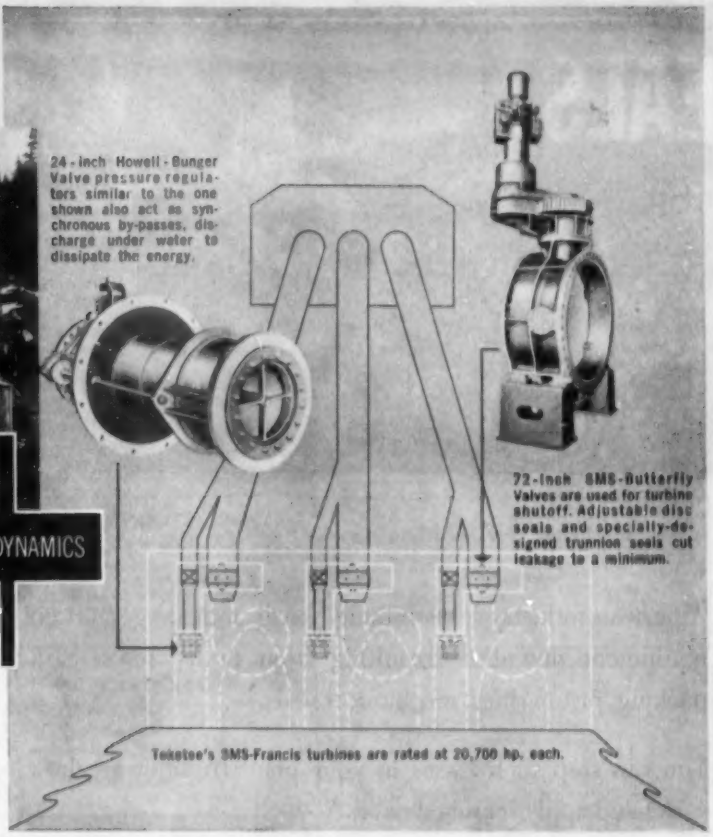
So the editors of ABC publications must constantly keep their editorial services up to the mark if they are to survive a competition in which the reader's right to buy or not to buy is paramount. Each paid magazine or newspaper will prosper or fail as it wins or loses the voluntary patronage of thousands or millions of readers. And—the ABC is scorekeeper in this vital contest.

Thus the publisher who submits his publication to the supervision and discipline of ABC affirms in the strongest possible manner his recognition that his primary obligation is to his readers and that he owes the standing of his publication to a voluntary demand by those readers.

All this is what makes the ABC brand on a publication so important to its readers. That respected symbol, testifying to the advertising value of the publication, serves also as a constant reminder to all concerned that the reader's willingness to pay for an ABC publication is the basic reason why it stays in business.

McGraw-Hill Publishing Company, Inc.

A single main penstock with a surge chamber feeds 3 SMS-Francis turbines operating under a 433-foot net head at Toketee.


24-inch Howell-Bunger Valve pressure regulators similar to the one shown also act as synchronous by-passes, discharge under water to dissipate the energy.
72-inch SMS-Butterfly Valves are used for turbine shutoff. Adjustable disc seals and specially-designed trunnion seals cut leakage to a minimum.
Toketee's SMS-Francis turbines are rated at 20,700 hp. each.

HYDRODYNAMICS

HOW COPCO'S NORTH UMPQUA PROJECT DELIVERS

Dual control arrangement of the Howell-Bunger Valves at Toketee makes it possible to pass a constant predetermined quantity of water regardless of turbine load. This helps control the down-river water level.

LOW-COST POWER

Eight years ago, the California Oregon Power Company was faced with a greatly accelerated load demand. To meet this challenge economically, a planned expansion program was started on the rugged, remote North Umpqua River. Today, eight new plants have added a total addition of 145,000 kw at an exceptionally low cost.

This North Umpqua project graphically demonstrates economy of construction and operation. One central station of conventional design – Toketee – remotely controls seven unattended single-unit, outdoor-type stations within a 12-mile radius.

Five SMS turbines, with a total rated output of approximately 124,000 hp, are used in this project. SMS accessories in five of these stations include 7 Howell-Bunger Valves – 3 of which are shown in the diagram interconnected with the Toketee turbines – 6 Butterfly Valves, 2 Elbow-type Pressure Regulators and 2 Motor-operated Trash Rakes. All are now in operation and exceeding guaranteed performance. To get full information on hydraulic turbines and accessories, contact us at York, Pennsylvania.

HYDRAULIC TURBINES
PUMPS
GATES & HOISTS
TRASH RAKES
ACCESSORIES
HYDRODYNAMICS
ROTOVALVES
BALL VALVES
BUTTERFLY VALVES
FREE-DISCHARGE VALVES
CONTROLLABLE-PITCH SHIP PROPELLERS

S. MORGAN SMITH

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED • TORONTO

SAVE WITH SEALS

American industry loses billions yearly in leakage and costly equipment downtime resulting from faulty seals—gaskets, packing, piston rings, mechanical seals.

You can stop such losses in your plant by knowing how to select and apply sealing devices.

Now, for the first time, the information you need to do this cost-cutting job is available in a single package.

HERE'S HOW:

Separately, these reprints are priced at 60¢ each. For a short time, we will send you all three, in an attractive data file FOR ONLY $1.50. And if you order now, will include a card enabling you to reserve Part 4 at a special prepublication price.

START SAVING TODAY

Order these reprints now—vital, practical, easy-to-use data giving all you need to know about gaskets, piston rings, packing, mechanical seals.

Gaskets. 20 pages of intensely practical material on gaskets. Covers various gasket materials including asbestos, natural and synthetic rubber. Neoprene, Kel-F, phenolic resins and metals. How to lay out, cut and install gaskets.

Mechanical Packing. Don't let any man in your plant tighten a gland nut until he grasps ideas in this report. Here are packing basics and know-how, never before told in print. Sketches, curves and detailed illustrations tell you how a packing seals, how it's applied, how to prevent costly rod and shaft wear.

Piston Rings. 24-page section gives the dope on the cylinder sealing problem in general, describes ring types, tells you where to use them. Passes along tips on installing, operating, renewing rings, plus making them in emergencies.

Mechanical Seals. Coming in 1956. 24 pages of illustrations and text showing and explaining in simple language what mechanical seals are, what jobs they do and how to apply them to your equipment. These seals do not wear your shafts, are now running up to 100,000 rpm, at 500 F without a drop of leakage, in smaller sizes.

ORDER TODAY— OFFER IS LIMITED

POWER
330 W. 42nd St.
New York 36, N.Y.

Please send ..... sets of Basic Data on Seals.
I enclose $.....
Include my special bonus card with each set

NAME .....
STREET .....
CITY ..... ZONE NO. ..... STATE .....

Please reply before October 15, 1955. This coupon void after that date.

WHERE TO BUY

Featuring additional products, specialties & services for power plants

A.C. Anywhere 350 Watts to 400 K.W.

with KATO GENERATORS

Larger sizes available in speeds of 720, 900, 1200, 1800 R.P.M. at 60 cycles. Can be furnished adaptable to engine of your choice. Many sizes available with direct or belted exciter. Odd frequencies from 25 to 400 cycles are our specialty. Can be arranged for standard S.A.E. engine bell housing adaptation.

Manufacturers of electrical machinery since 1926!

WRITE TODAY FOR FULL DETAILS AND FREE LITERATURE.

KATO Engineering Company

1479 FIRST AVENUE, MANKATO, MINNESOTA

The Traveling Activated Porous Fuel Bed

COMBUSTIKATOR

Continuous Ash Discharge Grate
Burns All Combustible Solids

AUTOMIC INCINERATOR ENGINEERS
18 East Erie Street Chicago, Ill.

STEEL PIPE & TUBING
• CHROME MOLY • CARBON MOLY
• MONEL • CARBON STEEL • STAINLESS
• HASTELLOY
Widest Range of Sizes & Specs in the U.S.
WRITE FOR STOCK LIST
Send us your Surplus Lists
MIDCONTINENT TUBE SERVICE, INC.
2308 Oakton St., Evanston, Ill. DA 8-4030

This
WHERE TO BUY
Section

supplements other advertising in this issue with these additional announcements of products and services essential to modern plant management and Maintenance. Make a habit of checking this page, each issue.
Classified Advertising Division
POWER

PROFESSIONAL SERVICES

BLACK & VEATCH
Consulting Engineers
Electricity—Water—Sewage—Industry
Reports, Design, Supervision of Construction
Investigations, Valuation and Rates
1706 Broadway Kansas City 12, Missouri

BURNS & McDONNELL
Consulting and Designing Engineers
Kansas City, Mo. Phone
P. O. Box 7088 Delmar 4375

GILBERT ASSOCIATES, INC.
Engineers and Consultants
Design and Construction Supervision
Industrial • Sanitary • Chemical Laboratory Services
Business and Economic Research
Industrial Relations • Purchasing
New York Reading, Pa. Washington

INTERNATIONAL ENGINEERING COMPANY, INC.
Engineers
Investigations — Reports — Design
Procurement — Field Engineering
Domestic and Foreign
74 New Montgomery St., San Francisco 5, Calif.

THE KULJIAN CORPORATION
Engineers - Constructors - Consultants
POWER PLANT SPECIALISTS
(Steam, Hydro, Diesel)
Utility • Industrial • Chemical
1200 N. Broad St. Philadelphia 21, Pa.

PETER F. LOFTUS CORPORATION
Design and Consulting Engineers
Electrical • Mechanical • Structural
Civil • Thermodynamic • Architectural
First National Bank Building
Pittsburgh 22, Pennsylvania

THE LUMMUS COMPANY
Engineers and Constructors
385 Madison Ave., New York, N. Y.
Chicago . . Houston . . London
Paris . . The Hague . . Montreal
Caracas . . Bombay

LUTZ AND MAY COMPANY
Consulting Engineers
Steam, Gas & Diesel Power Station
Pumping Plants—Electric Systems
Reports—Design—Appraisals
1009 Baltimore Kansas City 6, Mo.

MORGAN AND ASSOCIATES
Power and Utility Cost Consultants
Specialists in Cost Reduction Studies, Surveys, Analysis and Reports.
Electricity • Steam • Coal • Oil • Gas
Water • Air
1939 S. Taylor Rd. Cleveland 18, Ohio

PIONEER SERVICE & ENGINEERING CO.
Consulting and Design Engineers
Purchasing
Specialists in
Financing, Accounting & Other Operations
231 So. La Salle St. Chicago 4

SANDERSON & PORTER ENGINEERS
Design
Construction
New York New York

SARGENT & LUNDY
Engineers
140 South Dearborn St. Chicago, Illinois

SEELYE STEVENSON VALUE & KNECHT
Consulting Engineers
Mechanical — Electrical — Civil
Surveys Reports Design
101 Park Avenue New York 17, N. Y.

J. E. SIRRINE COMPANY
Engineers
Power Plant Consultations
Design Reports
Water Steam Utilization Plants
Greenville South Carolina

STANLEY ENGINEERING COMPANY
Consulting Engineers
327 S. LaSalle Street Hershey Building
Chicago 4, Illinois Muscatine, Iowa

A. L. SWANSON AND COMPANY
Consulting Engineers
Power Plants
Sawmills—Industrial Plant Layout
Heating—Ventilating—Plumbing
Reports, Designs, Drawings, Specifications
2210 West 12th Avenue Vancouver 9, B. C.

WATER SERVICE LABORATORIES, INC.
Water Treatment for corrosion control in buildings, boilers and air conditioning systems—Chemical Laboratory Services—Consultation.
New York—Philadelphia—Washington, D. C.

THE J. G. WHITE ENGINEERING CORPORATION
Design-Construction-Reports-Appraisals
80 Broad Street, New York 4

EMPLOYMENT OPPORTUNITIES

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

Positions Vacant
Positions Wanted
Part Time Work

Civil Service Opportunities
Selling Opportunities Wanted
Selling Opportunities Offered

Employment Agencies
Employment Services
Labor Bureaus

DISPLAYED ——**RATES**—— **UNDISPLAYED**

The advertising rate is $35.00 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on a column—3 columns—60 inches to a page.

Subject to Agency Commission.

$1.65 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box Numbers—counts as 1 line.

Discount of 10% if full payment is made in advance for 6 consecutive insertions.

Not subject to Agency Commission.

Send NEW ADS to POWER, 330 W. 42nd St., N. Y. for November issue closing October 11th

MECHANICAL ENGINEERS

Opportunities for young engineering graduates with interest in the power production engineering field.

Our work includes design and selection of power plant equipment; calculate heat cycles; write specifications for power plant equipment; assemble and check steam plant operating reports; conduct and report on engineering investigations; prepare system loading schedules and system economy and load forecasts.

These positions offer excellent opportunities for advancement to young men with heat power majors, in the expanding electric utility business.

Write direct giving age, education, experience, personal particulars and salary desired.

THE CLEVELAND ELECTRIC ILLUMINATING COMPANY
75 Public Square, Cleveland 1, Ohio

POWER ENGINEER

Wanted graduate mechanical or electrical engineer with no more than 3-4 years' experience in steam electric generating plant, hydraulics, refrigeration, instrumentation, and lubrication engineering.

Will assist in planning, design and direction of 14 boilers, 18 mm. lbs.-a-day steam plant, 15,000 k.w. generating plant and 22,000 k.w. electric distribution system.

Excellent working conditions. Located in city of 70,000. Liberal company benefits. Five day, forty hour week. Please send complete resume to Personnel Department.

A. S. STALEY MFG. CO.
Decatur, Ill.

MECHANICAL ENGINEERS

A prominent midwest utility has an immediate need for a graduate mechanical engineer with several years experience in power plant construction and design. This company offers an excellent opportunity for the right man to advance to a position of responsibility. Your reply should include age, education, experience, salary requirement and a recent photograph.

P-6823, POWER
520 N. Michigan Ave., Chicago 11, Ill.

COMBUSTION ENGINEER

For Research & Development of Gas & Oil Fired Burner Equipment for Industrial Processing. This Is a Newly Created Position with Many Interesting Possibilities.

WESTERN PRODUCTS, INC.
NEW CASTLE, INDIANA

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42 St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITIONS VACANT

Engineers—positions available to qualified men for the development and design of centrifugal pumps and centrifugal compressors. Knowledge of basic fluid, mechanics, thermo-dynamics as related to power plant equipment essentials. Worthington Corp., Harrison Division, 401 Worthington Ave., Harrison, N. J.

Want to live in sunny Tucson? Results engineer, assistant, or man in similar capacity, familiar with all phases of power plant operation, for technical studies and sales engineering with large established manufacturer of water treating equipment. Work in famous health and recreation area; ideal dry Southwestern climate. Write care Box P-7762, Power.

Position Vacant Power plant superintendent for a municipal steam electric generation plant. Present average load 3200 KW. Plant in good condition. Must understand full operation and be able to direct personnel. Apply to Carl W. Fuehrer, Borough Manager Ephrata, Pa. giving qualifications, salary expected, availability for interview and date position could be accepted.

POSITIONS WANTED

Engineer-Administrator: Registered professional engineer with twenty-five years experience and background of general mechanical engineering practice with increasing responsibilities (50 to 800 personnel) to top echelon positions. Have headed the mechanical engineering departments of two consulting engineering firms, one of international reputation and the other well known in Eastern U.S. also a U.S. Government "Commission" to rehabilitate the economy of a far eastern country. Personality and broad experience are geared for technical sales, industrial management or large project development. Activities have dealt with power, chemicals and industrial projects development. Construction exp. salary. Minimum $15,000. PW-7774, Power.

Position wanted as power superintendent or plant betterment engineer. Substantial experience in management of power plant operations, maintenance and repair. Presently employed as power superintendent. Desire change with greater security of future. PW-7655, Power.

Maintenance Engineer age 44, married, experienced in operations and maintenance high pressure steam power plants presently employed above position in 30,000 KW plant overseas go anywhere family can go. PW-7716, Power.

OPENING AVAILABLE AT LONG ESTABLISHED MEDITERRANEAN COPPER PROPERTY

ASSISTANT CHIEF ENGINEER

Age limit 45 preferably about 35. Must be graduate mechanical, chemical or civil engineer with natural mechanical ability, excellent practical and supervisory and some construction experience, for charge under Chief Engineer of all shops, foundry, mobile equipment including loading, marine, railway and construction; maintenance and repair of all types of equipment; 7250 KVA diesel generating plant.

Forward with initial reply complete educational and experience records, list of references, age, marital status, number and age of children, photo (optional). Company offers three year contract, furnished house, transportation self and family, liberal vacations. Excellent climate, living conditions, medical and hospital facilities. School to 14 years. Non-contributory pension plan. Salary open.

P-6780, POWER
1111 Wilshire Boulevard
Los Angeles, California

YOUR ORGANIZATION

Is it complete?
Are you expanding it?
Making Replacements?

Naturally, you are anxious to secure the most suitable man or men available. You want men with the special training that will make them an asset to your organization. You can contact such men through an advertisement in the Employment Opportunities Section of POWER.

Classified Advertising Division

POWER
330 W. 42nd St., New York 36, N. Y.

CLASSIFIED SEARCHLIGHT SECTION ADVERTISING

BUSINESS OPPORTUNITIES — EQUIPMENT - USED or RESALE

UNDISPLAYED RATE:

$1.65 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

PROPOSALS $1.65 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED RATE:

The advertising rate is $17.90 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page.

EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

Send NEW ADVERTISEMENTS to N. Y. Office, 330 W. 42nd St., N. Y. 36, N. Y. for November issue closing Oct. 11th

GET 2nd ENGINEER PAPERS IN 1 YEAR

(Yes, get better stationary engineers License!)

No correspondence school bother. Nationally-known Chief Stationary Engineer Frederick C. Walker's 100-Question, 100-Answer Bulletins give you the straight dope quick. Send $3 to Walker & Collins, 524 Ashland Ave., Buffalo 22, N. Y. for first set today. Keep working. Save year.

Prepare for REFRIGERATION LICENSE

More than 300 multiple choice questions from past exams. Many sketches. 96 pages 8½" x 11". Send $3 to:

W. D. TURNER

44 West 63rd St., New York 23, New York

WANTED FOR CASH

First-class used 15,000 to 20,000 KW, 3 phase, 60 cycle, 4000 volts condensing steam turbine generator unit, 285 to 300 PSIG, 665°FTT, complete with surface condenser and associated equipment. Furnish complete specifications, serial numbers with price.

W-7736, POWER

520 North Michigan Ave., Chicago 11, Ill.

WANTED

Steam Engine Generator Sets • Turbines • Condensers • Generators • Boilers • or Complete Power plants.

PAUL OBERMAN

1910 Delmar St. Louis, Mo.

2—TURBO GENERATOR UNITS

Westinghouse turbine, Max. press. throttle 340# P.S.I.G., Bleeder Station 110# P.S.I.G., Exh. 30# P.S.I.G Satu. Steam. Ser. Nos.—12750 & 12751.

W.H. AC gens., 1563 K.V.A., 480 volts, 1880 amps., 60 cyc., 3600 R.P.M., type SO-2G135, 80% P.F., 3 ph., Ser. No.—4953392-93.

W.H. DC exc., type SK, 16 K.W., 125 volts, 128 amps., 3600 R.P.M., frame 43, sty. No. 2G136.

Still on fndn. In exc. condition. Price and further inf. on request.

PHILADELPHIA TRANSFORMER CO.

Box 566 Delton, Pa. Ph.: 3-4811

625 KVA SKINNER UNIFLOW UNIT

1—625 KVA Electric Machinery generator, 3 phase 60 cycle 4160/2400/480/240 volts, 150 RPM, direct connected to Skinner universal uniflow engine, 125-165# steam pressure, 0-5# back pressure. New 1946—Excellent condition.

INTERNATIONAL POWER MACHINERY CO.
1510 Union Commerce Bldg., Cleveland 14, Ohio

CHECK WITH WAGNER FIRST

"Certified Rebuilt" Motors and Generators

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
300	Allis Ch. b.b.	BW	250	1000
200	Allis Ch. b.b.	BW	250	650
150	Whse.	SK-201	230	300/900
150	Whse.	SK-184	230	850
150	Gen. Elec.	BC-16	230	1700
100	Whse.	SK-173	230	850
100	Reliance	651T	550	1000/1600
100	Reliance	651-T	230	575/1150
75	Cr. Wh. TEFC	53H	230	850
75	F. Morse b.b.	DH-140	115	1800
60/75	Reliance b.b.	651-T	230	500/1500
50	Gen. Elec.	RF-14	230	800/1200
50	G.E. dynam. (4)	TLC35	250	1000/2500
50	Whse. (2)	SK-143	230	850
40	Whse. (2)	SK-133	230	850
35	Whse.	SK-163	230	300/900
30	Imperial b.b.	DH9	230	400/1600
30	Star b.b. (3)	5B	230	1750
25	L. A. TEFC	RNA	230	850

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
500	Whse.*	2300 AC	250 DC
300	Allis Ch.	2300/440 AC	125/250 DC
250	Allis Ch.	2300/440 AC	250 DC
200	Whse.*	230/440 AC	85 DC
200	Gen. Elec.*	230/440 AC	125 DC
200	Whse.*	230/440 AC	250 DC
150	Gen. Elec.	230/440 AC	125 DC
150	Whse.	2300/440 AC	275 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
105	Century b.b.	220/440 AC	70 DC
100	G.E.*	2300/440 AC	125 DC
100	Whse.	220/440 AC	250 DC
75	F. Morse b.b.	230/440 AC	125/250 DC
75	Cent. b.b.	230/440 AC	125 DC
60	Gen. Elec.*	220/440 AC	60 DC
50	Gen. Elec.	220/440 AC	125 DC
50	Whse.	220/440 AC	250 DC
40	Whse. (2)	220/440 AC	250 DC
30	Gen. Elec. (2)	230/440 AC	125 DC
30	F. Morse b.b.	230/440 AC	24 DC
30	Allis Ch. (3)	230/440 AC	250 DC
25	Whse.	230/440 AC	125 DC
20	Rel. b.b. (3)	230/440 AC	250 DC

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
300	Al. Ch.	MECW	125/250	1200
250	Allis Ch. b.b.	EW	250	1200
175	Allis Ch. b.b.	EW	250	900
150	Gen. Elec.	RC	250	1800
135	Whse.	SK-184	250	1150
105	Century b.b.	1500 amp.	70	1200
100	Whse.	SK-173	250	1150
100	Allis Ch.	E	125	1800
100	Reliance	651T	600	1800
75	F.M. b.b.	DG	125/250	1200
75	Cent. b.b.	D100X	125	1150
75	F.M. b.b.	DG	125	1800
75	Cr. Wh. bb (2)	CGD	250	1150
50	Whse. (2)	SK-143	250	1150
40	Whse.	SK-133	250	1150
25	G.E. b.b. (10)	CD85	250	2200
25	Whse.	SKD3	125	1750

A. C. MOTORS — 60 CYCLE

HP	Mfr.	Type	Volts	Speed
700	G.E.	Synch.	2200	514
700	Allis Ch.	Sq. Cage	440	900
700	G.E.	Synch.	2300/440	1200
600	G.E.	Slipring	2300/440	600
500	G.E.	Sq. Cage	4000	1200
500	G.E.	Synch.	440	900
450	Allis Ch.	Synch.	440	600
400	G.E.	Slipring	2300	900
400	Whse.	Sq. Cage	2300	514
400	G.E.	Synch.	440	450
350	Whse. (2)	Slipring	2300	450
300	Whse.	Sq. Cage	440	600
300	El. Machy	Synch.	230/440	360
300	Al. Ch.	Sq. Cage	2300/440	720
300	Whse.	Synch.	2300/440	600
300	G.E.	Slipring	440	360
250	Gen. Elec.	Synch.	230/440	450
250	G.E.	Synch.	230/440	720
250	L.A. (2)	Sq. Cage	2300	1800
225	G.E.	Synch.	230/440	900
200	G.E.	Slipring	2300/440	600
200	Whse. (2)	Slipring	2300/440	720
200	Gen. Elec.	Sq. Cage	230/440	1200
200	Reliance b.b.	Sq. Cage	230/440	1800
200	Allis Ch.	Slipring	440	450
200	Gen. Elec.	Sq. Cage	2300/440	720
200	Cr. Wh.	Sq. Cage	230/440	3600
200	Whse.	Sq. Cage	2300/440	900
200	E. M.	Synch.	230/440	1200
175	G.E. (2)	Synch.	230/440	720
150	G.E.	Slipring	220/440	900
150	Whse.	Sq. Cage	230/440	900
150	G.E.	Synch.	230/440	450
150	Allis Ch.	Slipring	2300/440	720
150	G.E. (2)	Sq. Cage	2300/440	720
150	Rel. b.b.	Sq. Cage	230/440	1200
150	Allis Ch.	Sq. Cage	440	450
150	G.E. vertical	Slipring	4000/2300	1200
125	G.E.	Slipring	220/440	720
125	G.E. TEFC	Sq. Cage	220/440	3600
125	Whse.	Sq. Cage	220/440	900
125	Rel. TEFC	Sq. Cage	220/440	1800
125	G.E.	Slipring	220/440	450
125	Allis Ch.	Slipring	220/440	900
100	L.A. b.b.	Sq. Cage	440	3600
100	G.E.	Slipring	220/440	514
100	G.E.	Slipring	220/440	900

A. C. GENERATORS — 60 CYCLE

KVA	Mfr.	Type	Volts	Speed
1000	Whse. syn cond		4000/2300	900
700	Gen. Elec.	ATI	2300/480	1200
625	Gen. Elec.	ATB	2300	450
600	Gen. Elec.	ATB	480	900
485	Allis Ch.	1 brg	480	400
312	Gen. Elec.	ATB	240/480	600
275	G. E. 25 cycle	ATI	480	750
225	El. Machy.		480	720
225	Gen. Elec.	ATI	240/480	900
156	Whse.	G	240/480	1200
150	Whse.		2300/480	600
75	El. Machy.		2300	900
56	G. E.	ATB	240/480	1200
37½	Whse.		240/480	1200

• These are only partial listings of our large stock — send us your inquiries for prompt attention and complete quotations. Quick shipment—fair prices—fully guaranteed. We save you time & money—safely!

SEND FOR WAGNER MOTORGRAM P-103

ARTHUR WAGNER COMPANY
1435 W. RANDOLPH ST.
CHICAGO 7, ILLINOIS
TELEPHONE MONROE 6-7409

BELYEA RE-NU-BILT

LARGE ELEC. POWER EQUIPMENT
SELECTED STOCK ITEMS
RE-NU-BUILT—GUARANTEED—RE-NU-BILT
COMBINATION MILL DRIVES — 15/2500 HP
D.C. MOTORS WITH M.G. SETS & CONTROLS

	MAKE	TYPE	VOLTS	R.P.M.
2200 HP	G.E.	MCF-13	600	440/880
2000 KW	G.E.	Syn.	2300/4600	514
1400 HP	G.E.	MCF14	600	63/100
1000 KW	G.E.	Syn.	4600/13200	720
1250 HP	Whse.	Ind.	600	300/450
1000 KW	G.E.	Syn.	2300/4000	720
1250 HP	G.E.	MCF	600	750/900
1000 KW	G.E.	Syn.	2300/4000	720
1000 HP	G.E.	MCF-8	600	850/720
1000 KW	G.E.	Syn.	2300/4150	720
500 HP	Whse.	Mill	600	300/900
500 KW	Whse.	Syn.	2300	1200
250 HP	Whse.	Mill	250	350/850
200 KW	Whse.	Syn.	220/440	1500
200 HP	G.E.	CD-1650E	250	500/1500
200 KW	Whse.	Syn.	440	1200

ALSO MANY OTHER COMBINATIONS

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	H.P.	Make	Type	Volts	Speed
1	1600	G.E.	MT-498	2300	300
1	1000	A.C.	Mill	2300	240
1	800	G.E.	MT	2300	593
1	750	A.L. Ch.	D.P.	2300	500
1	500	G.E.	MT-412	2300	580
1	500	Whse.	CW	550	350
1	500	G.E.	M-560Z	2300	1180
1	400	G.E.	IR-17B	2200	885
1	400	Whse.	CW-960A	440	1170
1	400	Whse.	CW	440	514
1	400	Whse.	CW-1218	2200	435
1	200	G.E.	MT-610	2200	435

SQUIRREL CAGE

1	500	G.E.	KT-573	2200	1180
2	450	G.E.	FT-560RY	440	3570
1	600	G.E.	K-6345B	2300	1185
2	450	Whse.	CR-1420	2300/4150	854
1	400	G.E.	IR-15B	2300	1185
1	400	G.E.	IR	2200	590
1	300	G.E.	IR-17	440	590
3	300	G.E.	KT-557	440	1800

SYNCHRONOUS

1	4250	C.W.	9501-BL	13200/6900	514
2	1750	G.E.	ATI	2300	3600
2	3000	Whse.		2300	120
3	725	G.E.	ATI	2300/13200	600
1	600	Ideal	RM	2300/4160	1500
1	500	G.E.	TM-7547	2300	1150
1	450	Whse.		2300	450
1	400	G.E.	TS	2300	600

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
2	2000/2400	G.E.	450	250/300	2300/4000
1	2000	G.E.	600 25rg	600	11000
2	2000	G.E.	514	600	6900/13200
1	1750/2100	G.E.	514	250/300	4000/2400
1	1500	G.E.	720	600	6600/13200
1	1250	C.W.	514	30/115	4000/13000
1	1000	G.E.	720	600	2300/4000
1	1000	G.E.	600	240	6000
1	750	G.E.	900	250	2300/4150
1	750	Whse.	900	250	2300/4150
1	750	C.W.	514	30/115	2300
1	750	G.E.	900	125/250	2300
1	600	G.E.	720	250	440/2300
1	500	Whse.	900	250	2300/4150
1	300	Whse.	1200	250	440/2300/4150
1	250	A.C.	900	125	2300/4000
1	250	Whse.	1200	250	220/440
1	150	Whse.	1200	600	2200

TRANSFORMERS

Qu.	KVA	Make	Type	Ph.	Voltages
1	3000	Wagner	HPW-30	3	26400x2400
1	4500	G.E.-Pur.	POWT	3	13800x2300/87

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltages
1	15500	Whse.	60/25	13200/13200
1	5000	G.E.	60/50/60	6600/11000/6600
3	2500	G.E.	25/60.5	2300/2300
1	1000	G.E.	25/56.5	4400/2300
1	500	Al. Ch.	5560	11000/2300

TURBO GENERATORS

Qu.	KW	Make	Data
1	4500	G.E.	Condensing 425 — 750 P.T.T. Surface Condenser 3/60/2300/4000 Y Direct conn exciter.
1	1500	Whse.	Auto. extraction 100 lbs.—600# P.T.T. 60 lb. extraction 3/60/440 Y. Dir. conn. Exc.
1	1000	Moore	Auto-Ext. Cond. 175/200# I.S.P. 5/20# G. Ext. Surface Condenser—3/60/2300.
1	1000	G.E.	Non-condensing 175/200 lbs. I.S.P. 5/20 lbs. G.S.P., 600/3/60.
1	750	G.E.	Condensing 265# I.S.P. 440 V. 3 ph. 60 cy.—New—1944.

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So—Buy SCHOONMAKER because you buy the FINEST in DEPENDABLE DIESEL POWER.

A PARTIAL LIST OF OUR INVENTORY

KW	MAKE	MODEL	HP	RPM
1180	Worthington	SEH-8	1685	360
1136	Fairbanks Morse	38D	1600	720
1100	General Motors	16-278A	1600	720
1000	General Motors	16-567B	1440	720
750	General Motors	12-567	1080	720
700	Worthington	EE-8	1000	327
675	Fairbanks Morse	38D	960	720
*500	Alco	6-12½x13T	750	600
500	General Motors	8-567	720	720
*350	Baldwin	VO-6	510	450
320	Superior	60-S-6	460	450
*320	Enterprise	DSG-6	460	450
300	Fairbanks Morse	32E14	450	300
300	General Motors	8-268A	450	1200
200	General Motors	8-268A	350	900
*160	Buckeye	8D	240	600
148	Fairbanks Morse	32E14	225	300
100	General Motors	3-268A	150	1200
60	General Motors	6-71	90	1200

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3 POWER TRANSFORMERS
13,800 to 2400 Volts. 667 KVA Each Oil Filled. New Condition.
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DIESEL UNITS

Two 62½ KVA 3/60/440-220 volts (mobile)
156 KVA & 219 KVA Buckeye, 514 RPM, 440/220 v.
312 KVA & 438 KVA Buckeye, 514 RPM, 440/220 v.
Two 187 KVA Buckeye, 400 RPM 440/220 v.
Three 1250 KVA General Motors, 2300/4150 v. 720 RPM.
350 HP and 450 Buckeye Diesels.

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440-220 Volts

625 KVA Al. Chal.—Elliott; 150/175#—0/10# bp
250 KVA E.M.—Murray; 100/150#—0/10# bp
250 KVA E.M.—Murray; 400#—30/110# bp
125 KVA GE, 135/200#—0/40# bp

FIRE PUMP—Motor driven:
1500 GPM Fairbanks Morse, 100 psig.

BOILERS: Babcock-Wilcox
Capacities from 250 to 1000 HP.

POWER PLANT EQUIPMENT CO.
175 Ivy Street, West Hempstead, N. Y.

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3—Kewanee Firebox Boilers, 304 HP, 125 PSI WP, Series 500, Model 580. ASME & Natl. Board stamped. New 1942.

3—150 HP Union Iron Works, 160 PSI, Bent Tube ASME, oil burners.

1—250 HP, B. & W. Stirling, 150 PSI, ASME, comb. gas & oil burners.

2—4' x 135' Steel Stacks.

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NEW UNIT HEATERS

20—Model 220 PL-Trane Propeller Type Steam Unit Heaters—½ HP Motors. 250,000 BTU Per Hour—New Cost $240.00 Our Price $175.00

TRANSFORMER

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1,000 Transformers, 5 KVA to 200 KVA

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16' 9"	4⅞"
18'	8"
16'	8"

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313 E. BALTIMORE STREET
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3—483 CFM—XLE COMPRESSORS
3 INGERSOLL RAND 125 HP, 220/440 V. NEW 1953, WITH AFTERCOOLERS
90 HP CYCLOTHERM STEAM GENERATOR
1—125 LB. PRES. PACKAGE BOILER OIL FIRED, LOCATED OHIO.
45 TON WHIRLEY CRANE
1—CLYDE E20—100' BOOM ELEC. NEW 1953.
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2000-2500-KW. at 80% PF., 2500-KVA.

A MODERN WESTINGHOUSE, 400# psig., 750°FTT., 2300-V. CONDENSING TURBINE-GENERATOR AN EXCEPTIONALLY GOOD MACHINE

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Two Rector St., New York 6, N. Y.

Rebuilt
HEMPHILL *Guaranteed* EQUIPMENT

TRANSFORMERS 60 CYCLE

Qu	KVA	Make	Type	PH.	Voltages
1	1000	Amer.	Pyranol	3	4150x480
1	750	G.E.	HT	3	4150x120/240
2	750	G.E.	H	1	4600x120/240
1	750	G.E.	Auto	3	4150x2400
2	500	G.E.	H	1	13200/22, 800Y-2300
3	400	Pitts.	OISC	1	4150x240/480
2	75	G.E.	Pyranol	1	2400/4160-240/480
3	50	G.E.	H	1	2400/4800-120/240
1	25	G.E.	Pyranol	1	2400/4160-120/240

SYNCHRONOUS MOTORS

QU	HP	Make	Speed	Type	Volts
1	1400	G.E.	514	ATI	4150
1	1000	Whse.	225	MIII	2300/4150
1	1000	G.E.	200	MIII	2300/4150
1	500	Whse.	450	HB	2300
1	300	EM	720	TEFC	2300
1	300	G.E.	600	ATI	600
1	200	Whse.	600	ATI	240
1	175	G.E.	720	ATI	2300
2	150	G.E.	1200	TS	4150
1	150	G.E.	1800	TS	220
1	150	Whse.	900	1SIG	220
5	150	Allis	380		2200
1	125	EM	180		4800
1	100	G.E.	900	TS	2200

SLIP RING MOTORS

QU	HP	Make	Speed	Type	Volts
1	500	G.E.	1200	M	2400/4150
1	400	Whse.	450	CW	550
1	250	Whse.	600	CW	440
1	200	Whse.	600	CW	440
1	150	A.C.	1800	AY RW	2300
1	100	G.E.	1800	IM	220
1	100	G.E.	600	IM	440
1	75	G.E.	600	IM	440
3	60	G.E.	1800	MT	220

MOTOR GENERATOR SETS

Qu	KW	Make	Speed	DC	AC.
1	1000	G. E.	514	600	2300/4150 3yn
1	1000	Whse.	720	600	2300/4150 3yn
1	1000	Whse.	720	275	2300/4150 3yn
1	300	G.E.	1200	250	2300/4150 3R
1	300	G.E.	1200	250	2300/4150 3yn
1	200	Whse.	900	250	2300/4150 3yn
1	150	C.W.	600	125	220/440 Y
1	100	G.E.	900	250	2300 3yn
3	97	G.E.	1200	60	4150 3yn
1	75	G.E.	1800	250	220/440 3C
1	60	Whse.	1200	60	2200V
3	60	EM	1200	125	220
1	50	Whse.SK	1750	250	2300V 3yn
1	30	Whse.	900	250	480
2	30	G.E.	1750	240	220/440
1	25	G.E.	1800	230	220 V 3yn
1	20	EM	1800	125	220 V
1	7½	Allis	1800	125	220/440
2	5	G.E.	1800	125	220/440
2	3	G.E.	1800	250	220/440

DC, 230 VOLT MOTORS

Qu	HP	Make	Speed	Type
1	300	G.E.	1200	MPC
2	150	C.W.	900	WP
1	125	G.E.	1700	RC
2	75	C.W.	900	WP
1	30	C.W.	700	CM
1	25	G.E.	900	RC
1	20	Whse.	850	SK

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2000 KW General Motors (Cleveland)—Elliott 4320 HP diesel-electric generating plant, complete with accessories, 3 units, 1000 KW each; like new, 1949, a.c. 3/60/2400/4160 v.
Also smaller sets. D.C. 1000 HP diesel set, 250 v. Locomotives. Cranes. Turbo-generators, 500-2000 KW.

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828 N. Broadway Milwaukee 2, Wis.

750 KVA VERTICAL UNIFLOW UNIT

1—750 KVA Allis-Chalmers generator, 3 phase 60 cycle 4160/2400/480/240 volts, 277 RPM, direct connected to Ames 4 cylinder vertical uniflow engine, 150-225# steam pressure, 0-5# back pressure. New 1933—Excellent condition.

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30 HP *200 lb.* Pressure Erie City Boiler
120 HP Kewanee Heating Boiler—complete
1500 & 2000 KW Turbo—Generator Sets
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10 Ton Steel Derricks—75' Booms
H. & P., 6719 Etzel, St. Louis 14, Mo.

37 Years Dependable Service

SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
600	2300	Whse.	450
500	2300/4000	G. E.	900
450	440	Whse.	514
450	440	Whse.	720
300	2300/440	G. E.	720
300	440	G. E. (hoist)	900
300	2300	G. E.	300
300	440	Whse.	3600
250	440/220	Whse.	600
200	550/440	G. E.	1200
200	440/220	Whse.	514
150 (2)	440/220	G. E.	720
150	2300/440	G. E.	600
135	440/220	G. E. (hoist)	600
125	440/220	G. E.	900
125	550/440	G. E.	1200
125	2300	G. E.	600

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
600	2300/440	G. E.	ATI	720
375	440/220	Whse.	GJ	900
300	440/220	Al. Mach'y.	Syn.	1200
300	2300/440	G. E.	T8	720
300	2300/440	G. E.	T8	1200
250	2300/440	G. E.	T8	720
250	440/220	Whse.	HB	277
250	440/220	G. E.	ATI	600
125	440/220	Whse.	HH	600

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
600	2300	G. E.	PC	3600
500	2300/4000	Elliott	MO	1800
500	2300	G. E.		450
400	2300/440	Whse.	CR	720
300	2300	L. Allis	FH	1200
250 (8)	2300/440	G. E.	KT	1200
200	440	G. E.	JK	720
200	440/220	G. E.	KT	1800
200	2300/440	G. E.	JK	600
200	2300	G. E.	KT	1800
150	440/220	Whse.	CR	900
150	2300	Al. Chal.	AH	1800
150	220	Whse.	CR	1200
150	440/220	G. E.	JK	450
150	440/220	G. E.	KT	720
150	2300/440	G. E.	KT	600

A. C. GENERATORS

1—320 kva, 600 rpm 2300/440/220 V., G. E.
1—300 kva, 900 rpm, 440/220 V., G.E.
1—225 kva, 60 rpm, 220/440 V., G.E.
1—200 kva, 720 rpm 2200/440 V., G.E. (Ball)
1—187 kva, 1200 rpm, 2200/440 V., Whse.

CIRCUIT BREAKERS

2—2000 amp. GG E., 2 pole, 600 V.
2—1600 amp. ITE, 2 pole, 600 V.
6—FKR-155-25, 600 amp., 15,000 V., G.E.
1—FKR-143, 1200 amp., 4500 V., G.E., Sol. op. (new)

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
225	230	Whse.	SK	2870
150	230	Whse.	SK	1750
100	230	Whse.	SK	400/1750
90	220	G. E.	CD	1750

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	2300	Syn.	250
175	G. E.	220/440	Syn.	230
125	G. E.	440/220	Syn.	550/1100
100	Al. Ch.	220/440	aq. cs.	240/120
100	Whse.	440/220	aq. cs.	125
75	G. E.	2300/440	Syn.	125
60	G. E.	2200/440	aq. cs.	250

TRANSFORMERS 60 Cy.

1—600 kva, Standard, 13,800-2300 V., 3 ph.
2—500 kva, Whse., 66000—2300 V.
3—333 kva, G. E., 12000—2300 V.
2—300 kva, G. E., 2300—575 V.
2—300 kva, G. E., 11000—2300 V.
2—200 kva, G. E., 4150—480/240 V.
3—150 kva, Al. Chal., 2400—240/480 V.
6—100 kva, Whse., 2400—120/240 V.

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6—100 KVA 60 cy. 1 ph. O.I.S.C. Transformers 2400-120/240.
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19—15 KVA 60 cy. 1 ph. Dry Type 240/480-120/240
15—25 KVA 60 cy 1 ph. Dry Type 240/480—120/240
8—37½ KVA 60 cy. 1 ph. Dry Type 240/480—120/240.
3—50 KVA 60 cy. 1 ph. Dry Type 240/480—120/240.
3—10 KVA 60 cy 3 ph. Dry Type 480—208Y/120.
2—37½ KVA 60 cy 3 ph Dry Type 480—208Y/120.

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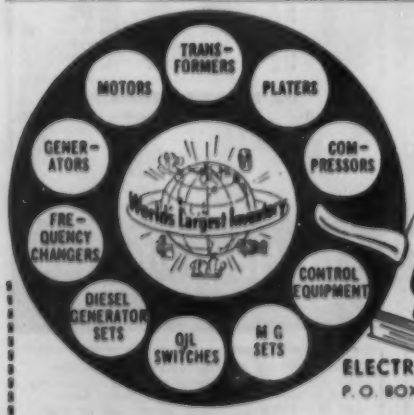

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MOTOR GENERATOR SETS

KW	MAKE	A.C.	D.C.
1000	G.E.	13,200	600
500	Westg.	2300	250
400	Al-Ch.	2300	120/240
400	G.E.	2300	270
300	G.E.	2300	250
200	G.E.	2300	250/275
200	Westg.	4160/2260	275
200	Ridgeway	2300	250
170	G.E.	440	125
150	Al-Ch.	2300	275

D. C. MOTORS

HP	MAKE	TYPE	SPD.
		*230 Volt	
250	Westg.	SK-220	450/600
200	Westg.	SK-201	650
200	Cr-Wh.	CM	500
175	G.E.	ELC	750
100	G.E.	MPC	400/800
100	G.E.	RC-34	2500
100	G.E.	RC-19	575
75/75	Westg.	SK-151	400/1600
50/120	G.E.	MCF	250/1000
50	Cr-Wh.	CMC	700/1100

SQUIRREL CAGE MOTORS

3 phase 60 cycle, 220 or 440 volts (*2300 volts or higher)

HP	MAKE	TYPE	SPEED
1250	*Al-Ch.	ANW	3600
1250	*Al-Ch.	ANW	1200
800	*Westg.	CS	3600
800	*Westg.	CS-1185	1200
700	*Westg.	CS	1200
700	Al-Ch.	AN	900
500	*Al-Ch.	6316-8W	1800
500	G.E.	KT-424	450
400	G.E.	KT-424	900
350	Ideal	A	1800
300	*G.E.	K-6344Y	1700
300	G.E.	K-6353 TEFC	720
250	G.E.	KT-5098	1800
250	*L.-Allis	OGK-148	720
250	*G.E.	4K	600
250	G.E.	4K-17A	600

SLIP RING MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

HP	MAKE	TYPE	SPEED
2000	*G.E.	MT	600
1500	*G.E.	MT-30	240
1250	Westg.	CW	600
1000	*Westg.	CW	450
700	*Al-Ch.	ANY	720
500	Westg.	CW	350
400	Al-Ch.	2 brg.	450
400	G.E.	IE-17	720
300	*G.E.	IE-15A	1800
250	Westg.	HP-15H	600
250	*G.E.	I-17B	450
200	G.E.	IK-15B	900
200	G.E	IM-17	600

SPECIALS!!!

PLATING GENERATOR SETS

AMPS	D.C.	MAKE	A.C.
7500/3750	6/12	Elec. Pilts.	220/440
2000/1000	6/12	Chandy	220
1500/750	12/24	Chandy	220
1500/750	6/12	Chandy	220
1000/500	12/24	Chandy	220
250	12	Hanson & VW	220/440
250	8	Holtzer-C	220

SPEED REDUCERS

HP	MAKE	MAX SPEED	TYPE & RATIO
250	W.A. Jones	1200	210 SH; 5.65:1
150	W.A. Jones	1200	180 SH; 5.65:1
20	Falk	1750	3026E; 9.394:1

CAPACITORS

36—15 KVAR Cornell Dubilier, type DB-11, 460 v./3 Ph./60 Cy. Indoor dust-tite, fireproof, non-explosive capacitors, complete with indiv. fuses & dis-charge resistors.

SYNCHRONOUS MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

HP	MAKE	TYPE	PF	SPD
1420	*West.		.7	900
800	G.E.	TS-EL	1.	1200
700	G.E.	TS-EL	.8	1200
600	*G.E.	TS-7640	1.	900
500	*G.E.	TS-7657	1.	514
400	*West.	H	.8	1800
400	West.	HG	1.	900
300	G.E.	ATI	.8	720
300	*Ideal	SMM	.8	257
300	G.E.	ATI	.8	900
250	G.E.	ATI	.8	900

CHICAGO *Electric Co.* — 1320 WEST CERMAK RD, CHICAGO 8, ILL.

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4 horizontal, 14 vertical, Westinghouse

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Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

G. M. DeROSE
2457 WOODWARD AVE.
408 DONOVAN BLDG.
DETROIT 1, MICH.

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Former Singer Manuf. Co. Power House Now Being Dismantled

ONLY 5 YRS. SERVICE

High Pressure, Bent Tube Type

#16658, #16659

Continuous Rating: 25,000 lbs. per hr.

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3 G. M. 200 KW DIESEL GENERATOR SETS

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EQUAL TO NEW

Complete with motor driven starting air compressors, air tanks, dual front type generator switch panels and all other necessary accessories.

ENGINES

G.M. Model 8-268A—6½x7—1200 RPM—air starting—complete with engine operating panels, heat exchangers, cooling pumps, filters, strainers, governors, pyrometers, etc.

GENERATORS

Westinghouse 250 KW 250 KVA—440/3/60—1200 RPM—80% P.F.—continuous—drip-proof enclosure—direct connected exciter.

SIZE AND WEIGHT

Each unit, mounted on a pre-fab sub-base, is 13' 9 5/16" long, 5' 10½" wide, approx. 6' high. Weight of engine and generator only, 17,705 lbs. Each unit, with all accessories, about 27,000 lbs.

CONDITION

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313 E. BALTIMORE STREET
BALTIMORE 2, MD CURTIS 7-5050

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Fairbanks-Morse Co.

1875 KVA	1500 KW	300 RPM
3 phase	60 cycle	2400 volt

Single Bearing direct connected Exciter. Formerly connected to 10 cyl Model 38E16.

In Good Condition

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ADVERTISERS' INDEX

This index is a service to readers. Every effort is made to maintain its accuracy, but POWER cannot assume responsibility for errors or omissions. When a star appears after the name, the advertisement does not appear in this issue but appeared in an issue within the previous three months.

ACEC Electric Corp. *
Air Preheater Corp. 251
Alco Products, Inc. *
Allen-Sherman-Hoff Co. Second Cover
Allis Chalmers Mfg. Co. 33-34-35-36, 41, 46, 62, 65, 145
Allpax Company, Inc. 226
American Blower Corp. 60-61
American Engineering Co. 212
American Gilsonite Co. 69
American Pulverizer Co. 198
Ames Iron Works, Inc. *
Anchor Packing Co. 165
Arkansas Fuel Oil Co. 253
Armstrong Cork Company 211
Armstrong Machine Works 149, 284
Automatic Incineration Engineers 289

Babbitt Steam Specialty Co. 240
Babcock & Wilcox Co. 6-7, 199
Babcock & Wilcox Co. (Tubular Products Div.) 185
Badger Mfg. Co. 283
Bailey Meter Co. 10-11
Baldwin Hill Co. *
Baltimore & Ohio Railroad *
Barber Colman Co. *
Bell & Gossett Co. 237
Belmont Packing & Rubber Co. 184
Betz Co., W. H. & L. D. 147
Biddle Co., James G. *
B-I-F Industries, Inc. 174
Bigelow Co. *
Bin-Dicator Co. *
Black, Sivalls & Bryson, Inc. 202
Blaw-Knox Company 188
Boiler Tube Co., of America *
Hotfield Refractories Co. *
Bridgeport Brass Co. *
Bros Boiler & Mfg. Co., Wm. *
Brown Boveri Corp. *
Buell Engineering Co. 180
Buffalo Forge Co. 265
Buffalo Pumps, Inc. *
Builders-Providence, Inc. *
Bussmann Mfg. Co. 72-73
Bryon Jackson Company *

Carey Mfg. Co., Philip *
Cash Co., A. W. 215
Catawissa Valve & Fittings Co. *
Celanese Corp. of America (Chemical Div.) 58
Champion Rivet Co. *
Chapman Valve Mfg. Co. 183
Chase Brass & Copper Co. 169
Chesapeake & Ohio Railway 32
Chesterton Co., A. W. 252
Chicago Exposition of Power & Mechanical Engineering 171
Chicago Pneumatic Tool Co. 59
Childers Mfg. Co. *
Cities Service Oil Co. 253
Clarage Fan Co. 273
Clark Bros. Co. 16-17
Cleaver Brooks Co. (Boiler Div.) 259
Cleveland Fuel Equipment Co. 218
Cochrane Corporation 70
Coffin, Jr. Co., J. S. *
Combustion Control Div. Electronics Corp. of America *
Combustion Engineering, Inc. 56-57
Condenser Service & Engrg. Co. *
Cooper-Bessemer Corp. 155
Copes-Vulcan Div., Continental Foundry & Machine Co. 14-15
Coppus Engineering Corp. 231
Corning Glass Works 240
Crane Company 4, 167
Crane Packing Company 242
Crawford Fitting Co. *
Cyclotherm Corporation 226

Darling Valve & Mfg. Co. 204
Dart Union Co. *
Deady Chemical Co. 250
Dearborn Chemical Co. 271
DeLaval Separator Co. *
DeLaval Steam Turbine Co. 2
Deming Company *
Detroit Stoker Co. 38-39
Diamond Power Specialty Corp. 8-9
Dodge Mfg. Corp. 269
Dow Corning Corp. 44
Dowell, Inc. *
Dravo Corporation 240, 261
Drew & Co., E. F. *

Eagle Picher Co. 114
Edison, Inc., Thomas A. *
Edward Valves, Inc. 45, 47
Electric Machy. Mfg. Co. *
Elgin Softener Corp. *
Elliott Company 12-13
Engineer Company 236
Erico Products, Inc. 217
Erie City Iron Works *
Ernst Water Column & Gage Co. 254, 289
Everlasting Valve Co. 248

Farr Company 236
Felt Products Mfg. Co. *
Fisher Governor Co. 233
Flexitallic Gasket Co. *
Foster Engineering Co. *
Foster Wheeler Corp. 10-19, 177
Foxboro Company *
Frick Company 226
Fuller Company 281

Garlock Packing Co. 206
General Cable Corp. *
General Electric Co. (Apparatus Dept.) 55
General Precision Equip. Corp. *
Goulds Pumps, Inc. 243
Graver Water Conditioning Co. 264
Green Fire Brick Co., A. P. 201
Green Fuel Economizer Co. 257
Greene, Tweed & Co. *
Grinnell Company Third Cover
Griscom-Russell Co. *
Gulf Oil Corporation 195
Gustin-Bacon Mfg. Co. 173

Hagan Corporation 28-29
Hall Laboratories 223
Halstead & Mitchell *
Hays Corporation 207
Hewitt-Robins, Inc. *
Heyl & Patterson, Inc. 263
Hoffman Specialty Mfg. Corp. 197

I-T-E Circuit Breaker Co. Switchgear Div. *
Illinois Water Treatment Co. *
Infilco Inc. *
Ingersoll-Rand Co. 225
International Nickel Co., Inc. 280
Iron Fireman Mfg. Co. 249
Irving Subway Grating Co., Inc. *

Jeffrey Mfg. Co. 276
Jenkins Bros. 153
Jerguson Gage & Valve Co. *
Johns-Manville 37, 163
Johnson-March Corp. *
Johnson Service Co. *
Joy Mfg. Company *

Kaiser Company, E. B. *
Kaiser Engineers, Div. of Henry J. Kaiser Company *
Kano Labs 284
Kato Engineering Co. 289
Keasbey & Mattison Co. 66
Kennedy-Van Saun Mfg. & Engrg. Co. *
Kewanee-Ross Corp. 213
Key Company 189
Kirk & Blum Mfg. Co. *
Klinger, Ltd., Richard 179
Klipfel Valves Inc. 285
Koppers Co., Inc. (Aeromaster Fans) *
Koppers Co., Inc. (Coupling Dept.) *
Kuljian Corporation *

Laclede Stoker Co. 192
Layne & Bowler Pump Co. 222
Leeds & Northrup Co. *
LeRoi Division, Westinghouse Air Brake Co. 68
Leslie Company 279
LimiTorque Corp. 283
Link-Belt Company 1
Lockett & Co., Ltd., A. M. *
Lunkenheimer Company *

Manning, Maxwell & Moore, Inc. 40, 282
Marley Company 274
Marsh Corp., James P. ..... *
Mason-Neilan Regulator Co. 156-157
McGraw-Hill Book Co. 256
McKiernan-Terry Corp. 255
Mercoid Corp. ..... *
Mesta Machine Co. 265
Midcontinent Tube Service, Inc. 289
Midwest Piping Co., Inc. 227
Minneapolis-Honeywell Reg. Co. Industrial Div. 48-49
Murray Iron Works Co. 200
Murray Mfg. Co., D. J. 214

National Airoil Burner Co., Inc. 186
National Aluminate Corp. 53-54
National Coal Association 221
National Tube Co. ..... *
National Valve & Mfg. Co. 241
Nebel Machine Tool Co. ..... *
Niagara Blower Co. 228
Nicholson & Co., W. H. 270
Nordberg Mfg. Co. 187
North American Mogul Products Co. ..... *
Norton Company 219

Ohio Brass Co. 235
Ohio Injector Co. 191
Orr & Sembower, Inc. ..... *
Owens-Corning Fiberglas Corp. 278

Pacific Pumps, Inc. 30-31
Pantex Manufacturing Corp. ..... *
Peabody Engineering Corp. 234
Pennsylvania Crusher Div. ..... *
Pennsylvania Flexible Metallic Tubing Co., Inc. ..... *
Pennsylvania Pump & Compressor Co. ..... *
Permutit Company ..... Back Cover
Perolin Co., Inc. ..... *
Petro 265
Philadelphia Gear Works 203
Philadelphia Pump & Machy Co. ..... *
Phoenix Mfg. Co. (Flange Div.) ..... *
Pittsburgh Piping & Equipment Co. 74
Powell Co., Wm. 209
Powers Regulator Co. 139
Pratt Co., Henry 232
Pritchard & Co., J. F. 63, 262
Proportioneers, Inc. 174
Pure Oil Company 239

Raybestos-Manhattan, Inc. Manhattan-Rubber Div. 272
Raybestos-Manhattan, Inc. Packing Div. 216
Refractory & Insulation Corp. 190
Republic Flow Meters Co. 42-43
Republic Steel Corp. 26-27
Research-Cottrell, Inc. 50-51
Revere Copper & Brass, Inc. ..... *
Ric-Wil Incorporated ..... *
Ridge Tool Co. 224
Riley Stoker Corporation 112-113
Rohm & Haas Co. (Resinous Prod. Div.) ..... *
Roto Div. of Elliott Co. 268

Sarco Company 159
Schaub Engrg. Co., Fred H. ..... *
Scovill Mfg. Co. 277
Sinclair Refining Co. ..... *
Smith Company, S. Morgan 287
Smith Corporation, A. O. 24-25
Socony Mobil Oil Co., Inc. 181
Solar Aircraft Co. ..... *
Sparkler Mfg. Co. ..... *
Spence Engineering Co. 275
Springfield Boiler Co. ..... *
Squires Co., C. E. 244
Standard Oil Co., of Indiana 229
Stephens-Adamson Mfg. Co. ..... *
Stickle Steam Specialties Co. 218
Stock Equipment Co. 298
Stone & Webster Engrg. Co. ..... *
Strong, Carlisle & Hammond Co. 210
Swartwout Company ..... *

Taylor Instrument Co's 247
Taylor & Co., W. A. 214
Tennessee Corporation ..... *
Terry Steam Turbine Co. 260
Texas Company ..... *
Todd Shipyards Corp. (Products Div.) ..... *
Toledo Pipe Threading Machine Co. 254
Tube Turns, Inc. 245-246

Union Asbestos & Rubber Co. 266
Union Iron Works ..... *
United States Gasket Co. 230
United States Gauge, Div. of Amer. Machine & Metals, Inc. ..... *
United States Rubber Co. (Mechanical Goods Div.) 258
U. S. Steel Corp. ..... *

Van Der Horst Corp. ..... *
Viking Pump Co. ..... *
Vogt Machine Co., Henry 267

Wallace & Tiernan Co., Inc. 198
Walworth Company 67
Warren Steam Pump Co., Inc. 238
Watson-Stillman Fittings Div. 161
Western Chemical Co. ..... *
Western Precipitation Corp. ..... *
Westinghouse Electric Corp. 20-21
Westinghouse Electric Corp. (Sturtevant Div.) 151
Wheeler Mfg. Co., C. H. ..... *
Where to Buy 289
Wickes Boiler Co. ..... *
Wiedeke Co., Gustav ..... *
Wiegand Co., Edwin L. (Ind. Div.) 225
Wilson, Inc., Thomas C. ..... *
Wing Mfg. Co., L. J. ..... *
Worthington Corporation 52, 193-194
Wright-Austin Co. 182

Yarnall-Waring Company 22-23, 141
Youngstown Sheet & Tube Co. 64

Zallea Bros. ..... *

Professional Services 289

CLASSIFIED ADVERTISING

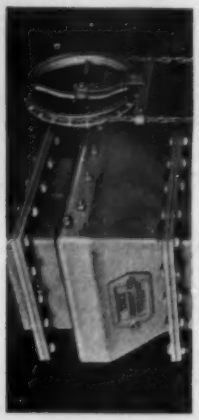
F. J. EBERLE, Asst. Mgr.

EMPLOYMENT OPPORTUNITIES 290
SPECIAL SERVICES 291
EDUCATIONAL 291
EQUIPMENT
(Used or Surplus New)
For Sale 291-295
WANTED
Equipment 291

ADVERTISERS INDEX

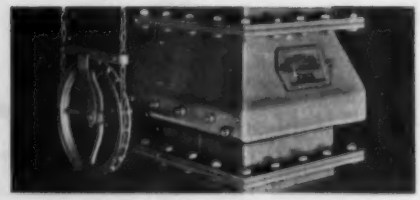
American Air Compressor Corp. 294
Atlantic Transformer Co. 294
Belyea Co., Inc. 292
Boston Metals Co., Inc. 292, 295
Chicago Electric Co. 295
Cleveland Electric Illuminating Co., The 290
Darien Corp., The 292
DeRose Corp. 295
Ebasco Services Inc. 293
Electric Equipment Co. 294
Electric Service Co., Inc. 295
Globe Trading Co. 294
Hall & Co., Stephen 294
Hammes Enterprises, Romy 295
Heat & Power Co., Inc. 292
Hemphill & Co., Inc. 293
H & P Machinery Co. 293
Howe Brothers 295
Industrial Electric & Supply Co. 292
International Power Machinery Co. 291, 293
Land, L. J. 295
McNeal Electric & Equip. Co. 294
Oberman, Paul 291
Philadelphia Transformer Co. 291
Power Plant Equipment Co., Inc. 292
Schoonmaker Co., Inc., A. G. 292, 295
Smith Co., H. Y. 293
Staley Mfg. Co. 290
Turner, W. D. 291
Utility Engineers Inc. 292
Wagner Co., Arthur 291
Walker & Collins 291
Weaver, Charles 293
Western Products Inc. 290

Any way you look at it . . .



you get more value when you

buy the New S·E·CO. Coal Valve



Any way you look at it the new S-E-Co. Coal Valve gives you more value . . . more life expectancy . . . more dependability . . . more ease of operation.

More life because of its heavy construction. The body is made of ⅜" thick steel with ¾" thick flanges. More life because stainless steel is used to combat corrosion — as gate liner, for pinions, gate rollers and grease seal retainers.

More dependability of operation due to the unique ladder racks and multiple faced pinions, both of which are self-cleaning so that tooth engagement is sure. More dependability since two racks are used, one on each side of gate, located far above normal coal flow, to assure straight line gate movement without jamming or binding.

More ease of operation due to large gate supporting rollers equipped with ball bearings and grease seals for pressure lubrication from outside the valve body.

The best costs little more than the average. A S-E-Co. representative would be happy to talk it over with you.

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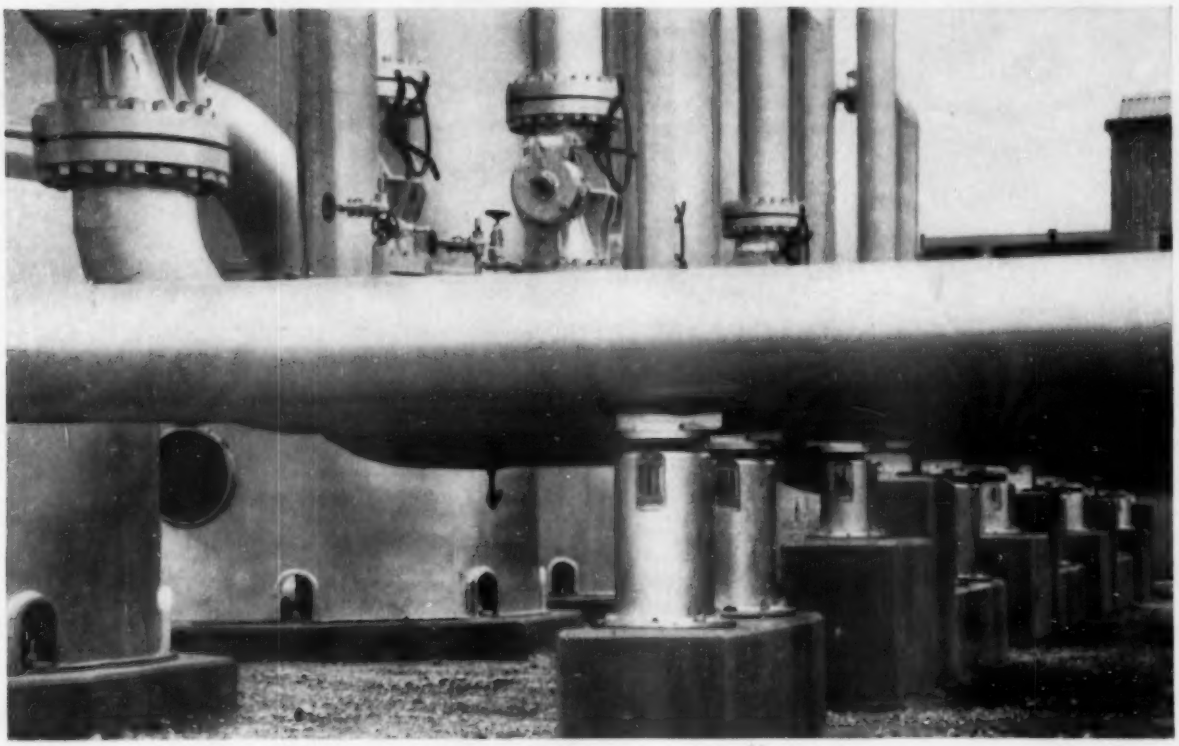
BUNKER TO PULVERIZER AND
BUNKER TO STOKER EQUIPMENT

STOCK Equipment Company

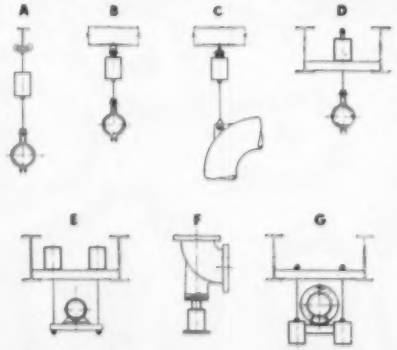
745-P HANNA BLDG., CLEVELAND 15, OHIO



For *flexible* support of piping

Grinnell Pre-Engineered Spring Hangers

AVAILABLE IN 7 TYPES FOR THESE TYPICAL APPLICATIONS



(Type A) Rod threaded to top cap (Type B) Furnished with single lug (Type C) Two lug style (Type D) Top adjusting (Type E) Adjustable top and bottom (Type F) For base support (Type G) Trapeze assembly.

The Grinnell Pre-Engineered Spring Hanger was developed after years of experience in analyzing the problems of flexible pipe suspension systems. It is *pre-engineered* to minimize changes in supporting force over total range of movement. Consider these outstanding features:

- **Maximum variation in supporting force per ½" of deflection is 10½% of rated capacity — in all sizes.**
- **Precompression* assures operation of spring within its proper working range, as well as saving valuable erection time. Reduced over-all height saves space.**
- **Solid steel casing protects spring from damage and weather. Guides assure continuous alignment and concentric loading of spring.**
- **18 sizes available from stock for load ranges from 53 lbs. to 12,000 lbs.**
- **Available in 3 spring lengths for travel ranges of 1¼, 2½, and 5 inches.**
- **Installation is simplified by integral load scale and travel indicators.**

***Precompression is a patented feature.**

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AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

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pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
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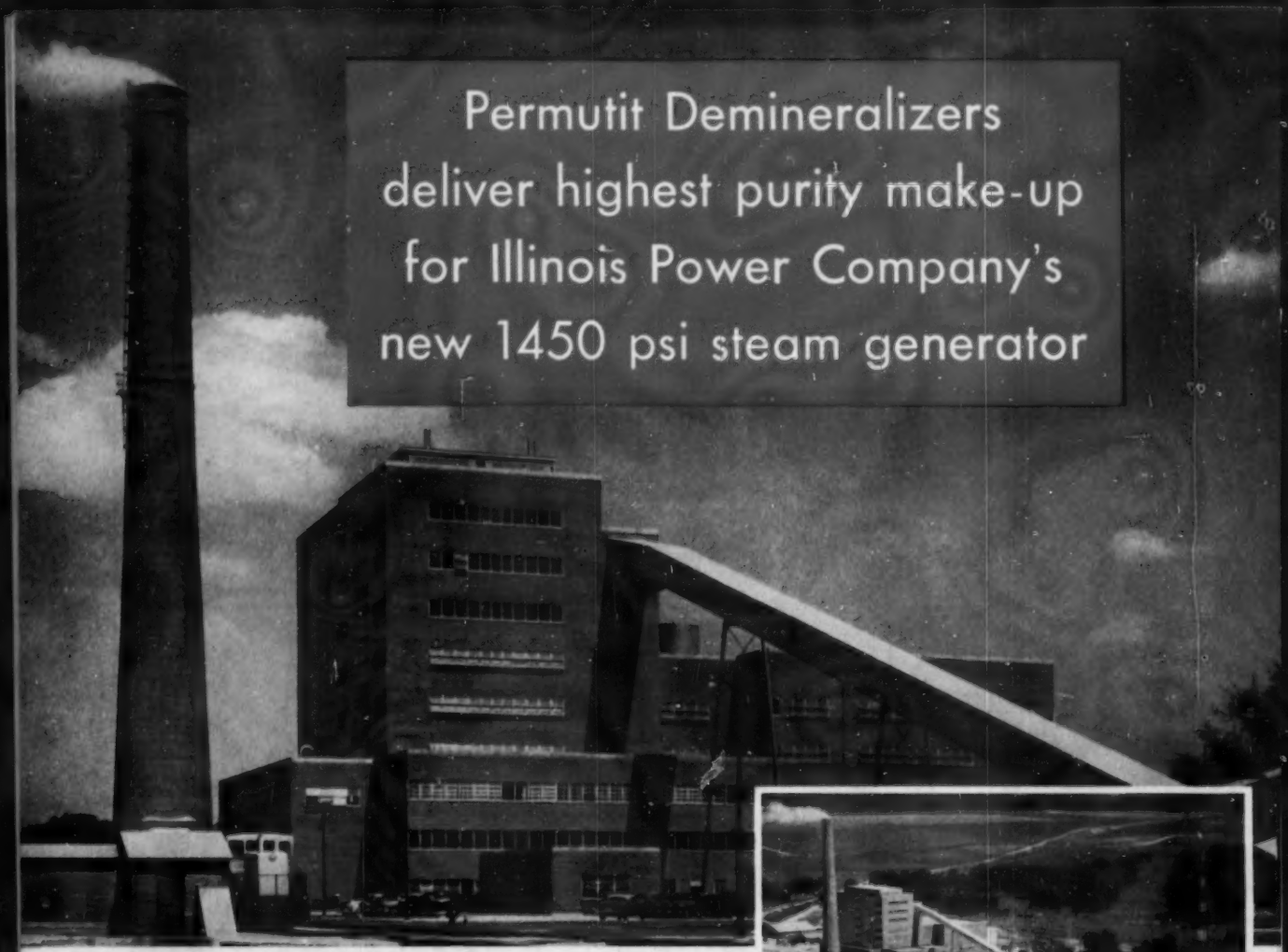
Permutit Demineralizers deliver highest purity make-up for Illinois Power Company's new 1450 psi steam generator



Hennepin Power Station, Illinois Power Company. Steam Capacity 525,000 lb/hr. Consulting Engineers: Sargent & Lundy

This plant's 75,000 KW turbo-generator must operate continuously at high efficiency.

Tips of turbine blades turn at speed faster than sound. At these speeds, slight amounts of *silica* in make-up water quickly build *dangerous* deposits—destroy turbine efficiency, cause costly shutdowns.

To prevent these troubles, all make-up water is demineralized by the Permutit equipment shown below. Silica is reduced from a harmful 14 ppm to as low as 0.02 ppm—*at low cost!* Total dissolved solids are reduced from 298 to 1.0 ppm!

This keeps 76 miles of boiler tubing free of scale with little or no blowdown. It permits the *high* heat-transfer rates demanded with 1010° F steam at 1450 psi.

Write to us for aid in solving your water problem. Permutit makes the world's most complete line of ion exchangers and water conditioning equipment. We can help save you time and money with the one combination that best suits your needs.

The Permutit Company, Dept. P-10, 330 West 42nd Street, New York 36, N. Y., or Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

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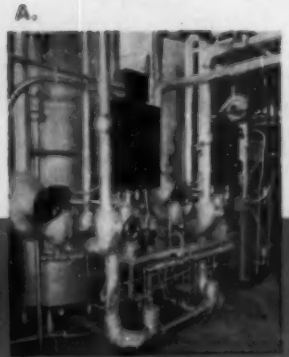

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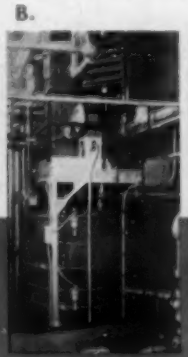

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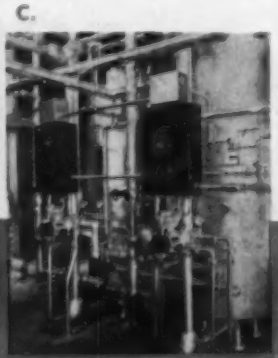

A. *Automatic Permutit Q units remove metallic cations from well water supply.*

B. *Permutit Degasifier removes CO_2, reducing operating cost.*

C. *Automatic Permutit S units remove remaining troublesome mineral impurities by anion exchange.*

Ion Exchange and Water Conditioning Headquarters for Over 40 Years.

PERMUTIT®